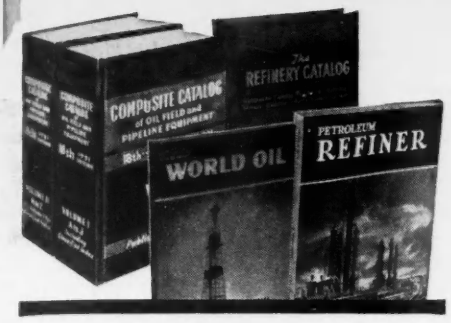

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for the refining-natural gasoline industry

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Looking Ahead

SUBSTANTIAL DECREASE in U. S. crude production is indicated for April. Texas allowable of 3,044,340 barrels daily represents cut of 115,137 daily. It allows 22 producing days generally and 19 in East Texas. Louisiana allowable of 656,350 barrels daily involves increase of 2678 barrels.

U. S. COURT OF APPEALS for District of Columbia likely will not hear arguments until next fall in case involving Federal Power Commission decision that it could not regulate Phillips Petroleum Company, whose interest in gas is limited to production. FPC decision was appealed by cities of Detroit, Kansas City, and Milwaukee, state of Wisconsin, Wisconsin Public Service Commission, and Wayne County, Michigan. FPC is defendant in each case. Motions to intervene have been granted to Phillips Petroleum Company, state of New Mexico, and New Mexico Oil Conservation Commission.

FOLLOWING 45,000 well completions in 1951, industry should step up completions by 5000 each year at least for the next few years. This is necessary to provide producing ability adequate to meet rising demands and to build up a larger margin of reserve producing capacity.

SEVERAL YEARS will be required to develop the Spraberry Trend of West Texas, which is developing into the world's largest oil field. A continuous oil reservoir covering over 1 million acres is indicated. Retarding factors in development include poor quality of a part of the reservoir and shortages of steel and other needed materials. Wells will go on artificial lift early, and recoveries by primary method will be low, although increased by special drilling and completion techniques. Prospects for production by secondary recovery are not especially promising. First productive three years ago, the field now has nearly 1100 producing wells in 20 areas over several counties and has produced about 25 million barrels of oil.

OIL SEARCH in Southeastern States has been stimulated by Pollard oil field discovery of Humble Oil & Refining Company in Escambia County, southwestern Alabama, just north of Florida state line, although a second well one mile east of discovery was dry. Refinements have improved accuracy of seismic work in the area, which has sediments equivalent to those on Louisiana coast.

INCREASED DEPENDENCE of U. S. on foreign oil in recent years is cause for some misgivings, as domestic production is most dependable source for emergencies. However, oil deficiency is small compared with deficiencies in U. S. production of numerous important minerals, including copper, lead, and zinc. U. S. net imports of petroleum (imports less exports) were equivalent to 8.4 percent of domestic demand in 1950 and came down to 6.0 percent in 1951. In contrast, the U. S. imports 31 percent of its copper, 44 percent of its lead, and 41 percent of its zinc. There is urgent need for development of more domestic deposits of those essential minerals.

ARTIFICIAL SHORTAGE of petroleum on West Coast in coming years is foreseen by Union Oil Company of California unless prices of crude and products are permitted to increase and give incentive for intensified exploration and development of new reserves. This prospect was described in application prepared by Union for filing with Office of Price Stabilization, asking for upward price adjustments averaging 60 cents per barrel on California crude.

U. S. MILITARY is unlikely to accept Petroleum Administration for Defense recommendation to reopen Elk Hills Naval Oil Reserve to alleviate shortage of crude and military products on West Coast.

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FOR INCREASED OIL AND GAS PRODUCTION

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Here's the Dowell Jel-X Family

ETCHING ACID—Jel-X 100 is a slightly viscous solution which has proved effective for use in limestone and dolomite formations with either fractured or vugular porosity. It is designed to etch and enlarge fractures or "vugs"; clean fractures by removing mud, silicate and feldspar materials; penetrate formation farther from the well bore than ordinary acid.

CHANNELING ACID—Jel-X 200 is a fairly viscous solution which has proved effective in limestone and dolomite with some intergranular porosity. It is designed to form channels deep into pay formations. These channels permit the entrance of acid into zones far from the well bore, reaching production that might otherwise be untapped.

STRATA-LIFT—Jel-X 300 and 400 are very viscous solutions which have proved effective in problem wells completed in dense limestone or dolomite. They are designed to open new fractures and extend old ones, and to dissolve soluble portions of the formation. Strata-lift may carry suspended sand which operates as a propping or abrading agent; needs no following jel-breaker solution.

STRATA-FRAC—Jel-X 500 is a fairly viscous fluid which has proved effective in sandstone, chert, chat and conglomerate formations. It is designed to dissolve soluble materials including silicates, paraffins and other heavy hydrocarbons; and to open new fractures or enlarge old ones. Strata-frac carries suspended sand as a propping or abrading agent; needs no following jel-breaker solution.

TEMPORARY PLUGGING SERVICE—Jel-X 700, 800, 810 and 900 are very viscous solutions which have proved effective in selective acidizing. They are designed to shut off the more permeable zones, permitting acid to be injected into the tighter formations. They are particularly useful in wells having multiple zone completions.

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FOR OIL INDUSTRY CHEMICAL SERVICE

Editor's Page

TREMENDOUS DISCOVERY TASK AHEAD

SHARPLY RISING CONSUMPTION is imposing a tremendous discovery task on the U. S. oil industry. Due to enlarged production rates it now has to find 4 billion barrels of new oil each year in order to maintain the nation's normal relationship between crude reserves and current production rates, while only 2½ billion barrels was sufficient ten years ago.

Such large discovery rates never have been maintained in the past, so the job ahead is much greater than before. Mechanization of the country continues, indicating even further sharp gains ahead in oil-consuming rates. Every increase in consumption requires greater production volumes, and every increase in production enlarges the need for finding larger quantities of new oil in order to have sufficient producing ability to satisfy requirements.

In view of this tremendous discovery task, it is noteworthy that this country continues to expand its oil-finding rates. A record quantity of oil has been found since the war. More new oil has been discovered in the last six postwar years than in the six prewar years. The existence of nearly 20 billion barrels of additional oil has been proven since the war in contrast with the finding of only 15 billion barrels in the same period before the war. Last year witnessed the discovery of more new oil than in any single previous year.

However, the larger volume found since the war has not been sufficient to maintain the industry's normal ratio with producing rates. This is due to the great increase in production. Before the war, an average of two barrels was found for every barrel produced, but enlarged postwar discoveries have averaged only 1.8 barrels per barrel produced.

As a result of finding fewer barrels in ratio to recent production rates, U. S. crude reserves at the end of 1951, although at an all-time peak, were equivalent to only 12½ barrels for every barrel produced during the year. Before the war it was normal for crude reserves to be 14 times greater than the existing rate of production.

To find the unusually larger amount of new oil discovered since the war, the industry has stepped up its over-all drilling rate by 50 percent and has enlarged its wildcat or discovery drilling effort by 2½ times. Nevertheless, the growth in drilling has not kept pace with the gain in production. Although wells drilled in search of oil or gas production totaled 43,643 in 1951 and 42,173 in 1950 in contrast with a prewar peak of 32,305 in 1937, the drilling volume during 1937 constituted 25.3 wells for every million barrels produced while the much greater 1951 drilling activity represented only 19.4 wells per million barrels of production.

• • •

THERE HAS BEEN an amazing growth in postwar wildcat drilling. The 9705 wildcats completed in 1951 were almost triple the 3409 completed in 1941 and were double the 4242 drilled as recently as 1946. As expected, this has resulted in the completion of more dry holes until twice as many failures were drilled in 1951 as in 1941. Consequently, dry holes which were accounting for only 20 percent of all drilling in 1937 increased to 30 percent in 1946 and to 39 percent in 1951.

To provide enough oil in future years it will be necessary to drill a larger number of wells, including more wildcats. But the number of dry holes needs to be reduced.

The need for finding greater amounts of oil places a great responsibility on the industry, much of which falls on geologists, geophysicists and paleontologists—the exploration branch of the industry, which has the direct responsibility of discovering new sources of oil. Theirs is the task of finding the increasing volumes of oil which must be available in the future. They must find the locations on which to drill a growing number of wildcats each year. This represents a challenge to their ability and ingenuity, the like of which has never been faced by their profession before.

Warren L. Baker

here's the plug

proved best by thousands of runs

Truth of the saying "Nothing succeeds like success" is outstandingly proved by the BAKER RETAINER BRIDGE PLUG! The "well proved" design—based upon the long famous Baker Cement Retainer—has performed successfully in countless thousands of wells—for every purpose—at all temperatures—and at all depths.

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Why not call the Baker representative in your area and discuss with him installation of a Baker Bridge Plug? You will find that he has valuable knowledge and helpful suggestions to solve your problems.

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RETAINER BRIDGE PLUG

The Changing Panorama

Scrapping of Controls Now Widely Urged

MANY IN the oil industry agree with business men generally and the U. S. Chamber of Commerce that wage and price controls should be abandoned when their legislative authorization expires June 30.

A large group of prices are now below ceilings, and prices of many commodities are declining. In such circumstances, price controls only serve as an irritant to the business trying to comply with regulations. With prices under ceilings, there is no benefit to consumers. Costs to the consumer are increased, in fact, as he must pay, in the form of taxes, the heavy governmental costs of administering the complicated control system that requires many extra government employes.

The Office of Price Stabilization, responsible for maintaining price controls, spent more than $45 million in the eight months of the current fiscal year, from July 1, 1951, to March 1, 1952, out of a total annual budget of $71 million allocated to the agency for fiscal 1952. The OPS work force increased from an average of 7405 persons in 1951 to 11,796 on March 1, 1952. Of the latter total, 2476 employes were in the national office and 9320 in the field.

These millions of dollars and thousands of persons were required to keep prices from rising as they might have done under normal supply-demand relationships. However, since the nation now has a plentiful supply of most consumer goods, while only a few items of industrial raw materials are actually in short supply, the question arises whether it would not have been cheaper to the taxpayers in the long run to have footed the bill directly for higher prices that might have prevailed temporarily under no controls than to have been saddled with continuing costs of millions of dollars annually for running OPS.

Business firms, for their part, operating under the onerous price and wage controls, must waste money and the time of regular and extra employes in the non-productive work of trying to comply with regulations. Business profits are reduced, and insofar as lack of profits exempts business from paying income taxes, an increased part of the tax burden falls back upon the public or the consumer. In the form of price and wage controls, as in all other forms, bureaucracy is costly and wasteful and must be paid for ultimately by the taxpayer.

Wage controls have failed as preventives of inflation, as weekly earnings have risen 13½ percent since the Korean War began. Their most significant result has been to give the federal government greater power over workers.

The strongest weapon against inflation must be found not in surface or secondary controls, such as price ceilings, but in fundamental or primary controls, such as governmental budget balancing, sound policies on money and credit, and encouragement of savings, both public and private.

Defense Mobilizer Wilson has backed President Truman's demand for extension of the Defense Production Act, with price and wage controls, for two years and repeal of the Capehart and Herlong amendments that modified the law. However, there is much sentiment in Congress for including provisions of decontrol in any extension of the act. Some proposals would make decontrol automatic by law on fulfillment of certain conditions. But as might be expected, administrators of price controls have indicated that they want to do any decontrolling administratively, at their discretion, without a law. This of course would mean no real decontrolling—only a perpetuation of controls and controlling jobs.

The Independent Petroleum Association of America has submitted a brief to the Office of Price Stabilization and to the Senate Banking and Currency Committee, urging removal of price control of crude oil and natural gas. The brief pointed out that present price ceilings on crude and natural gas are "unnecessary, inequitable, and impractical to administer."

Price controls seriously weakened the petroleum industry in the World War II period, and if continued they will do so again.

Yank Dollars Can Still Be Spent, Solons Find

OUR TRAVELING lawmakers in several groups covered the world last summer primarily to see if the American dollar they voted to spend abroad was being spent, and if more dollars could be spent abroad.

One of the groups' findings, which were not made public until late in March, should be entitled "How Naive Can We Be," or to steal a song title, "South America, Take It Away."

The House Interstate and Foreign Commerce Committee, four years ago warned of a possible emergency in producible U. S. petroleum reserves or a variation of the running-out-of-oil theme. In its report of last summer's escapades, the group states:

"Unfortunately, to some extent the emergency visualized is partially here. . . ."

The committee adds: "From the point of view of Latin American countries the stimulus prompting the development of petroleum reserves is just as strong, if not more intensified, today than in 1948." In other words, the committee is publishing what is already known. Latin America would like to have a lot of Yankee dollars. And it was emphasized that petroleum dollars would be appreciated.

Taking Latin America as a group, the ones where American private capital enterprise could have anywhere near complete freedom of operation can be counted on three fingers of one hand. Presumably the following also would like Yankee dollars: Mexico (expropriated the oil industry in 1938); Guatemala (legislated the infant private capital oil industry out of the country in 1949); Bolivia (expropriated American capital in 1937); Brazil (same thing, same year); Argentina (foreign companies are tolerated provided they adhere to Peron's laws).

In conclusion, indicating that a nice junket was had by all, the committee had high praise for the industrialization effort in Latin America, saying much of it was accomplished with little outside financial aid.

Report from the Observatory

STOCKS ADEQUATE, OUTLOOK FAVORABLE

By RAY L. DUDLEY, Publisher, and WARREN L. BAKER, Editor

SUBSTANTIAL IMPROVEMENT in inventories has enhanced petroleum's economic position to the point the industry enters the motoring season in very good condition. With the exception of residual fuel stocks, which are in short supply, inventories are adequate but not excessive. This is in contrast with the outlook of a few months back when it was feared excessive stocks of crude, gasoline or distillate fuel would be on hand by April.

Consequently, no major economic problems confront oil markets at this time, the only concern being some mal-distribution of inventories. Generally speaking, stocks have been reduced in California and enlarged elsewhere.

To a very large extent the present all-around favorable position of the industry is the result of refineries adjusting output of various products to consuming rates.

The improvement has been general among the industry's principal products during late weeks and months. Despite larger producing rates than a year ago, the upward trend of crude oil stocks during late 1951 has been checked by drafts in recent months. Heavy withdrawals have reduced distillate fuel inventories sharply, and they now are only a little above year ago volumes. Although gasoline stocks are at an all-time peak, a slower rate of growth lately has reduced the margin of increase over 1951 quantities until they now offer no economic problem.

• • •

CRUDE OIL STOCKS now are slightly lower than at the beginning of the year, and nearly 10 million barrels less than at the close of October. The 252¾ million barrels of crude in tanks on March 15 contrasted with 256¼ million barrels on January 1 and with 255 million barrels in mid-February.

Although April normally sees crude runs to refinery stills sag to the lowest point of the year, little ill effects should be reflected this year because of the 115,000 barrel per day reduction in Texas' permissible production allowable during April, the sharpest cutback since December, 1950. Half of the reduction will be imposed on West Texas fields, where storage has been increasing steadily for over a year due to insufficient pipe line capacity and the development of many important new producing fields. This action should afford some relief for overflowing West Texas storage tanks, where about three-fourths of the nation's additions to crude inventories have occurred during the past year.

In terms of gain over year ago volumes, crude stocks appear high only because of the exceptionally small inventories which existed during the early months of 1951. Following a 15-million barrel draft in the preceding three months, only 233¾ million barrels were in tanks at the end of March last year. This low level made it desirable to add to storage, and crude stocks were enlarged until they reached 262¼ million barrels by the end of last October, or about 10 million more than on hand at present. In terms of days' supply, less crude now is in tanks than at the close of the war.

• • •

A SLOWER RATE of accumulation has brought gasoline inventories more closely into line with year ago volumes, and these stocks no longer are a source of worry although at an all-time high. They will begin dropping during the next month as the motoring season commences.

At the beginning of the year there were 6½ million more barrels of gasoline in storage than a year ago and this increased to a 7½-million barrel gain by mid-January. However, the volume in tanks by the middle of March was only slightly over 5 million barrels greater than at the corresponding period of 1951.

In view of increased demand, motor fuel inventories are not at all excessive, representing only about 48 days' supply despite being at an all-time peak of 146 million barrels. Except for some distortion resulting from too large an increase in Midwest tanks and a reduction in West Coast supplies, motor fuel inventories offer no economic problem to the industry as they soon will begin to decrease with greater motor car travel.

• • •

VERY LARGE DRAFTS have reduced record stocks of distillate fuel oil sharply during recent months, as cold weather pushed consuming rates to peak volumes. Consequently, instead of being excessive, inventories of this product now are only 3 million barrels above year-ago levels. This reflects a material improvement, as at the end of October they had been 17 million barrels higher than the year before and were still 11⅔ million barrels greater at the beginning of the year. Consequently, it will be necessary to make major additions to distillate fuel inventories before the start of the next heating oil season in November. This will make it possible for refiners to manufacture large quantities of motor fuel in the months ahead without overflowing heating oil needs, and create a stable market for crude.

As with gasoline, too much of the increase in distillate stocks has taken place in the Midwest states while reductions on the West Coast make supply lower than desired levels. Shifting of some military purchases of light fuel oil to the Gulf Coast during the next month should help correct the low level of inventories in California.

Some additions need to be made to residual fuel stocks, though there has been considerable improvement in supply of this product in recent weeks. From a January and February "scramble" on both coasts residual fuel markets have changed to a near balance in supply and demand in the East and to a better balance in California. Stocks in the latter region, however, remain low but may improve through shifting of military purchases to other areas.

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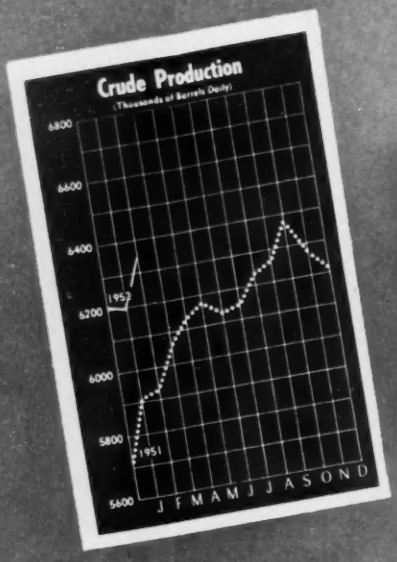
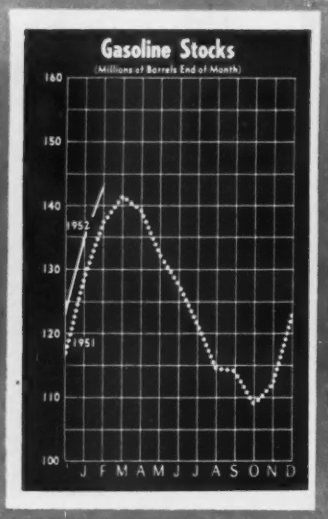
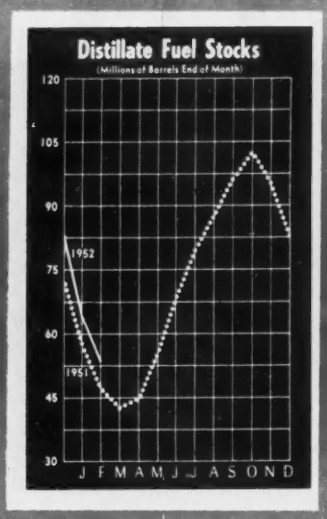
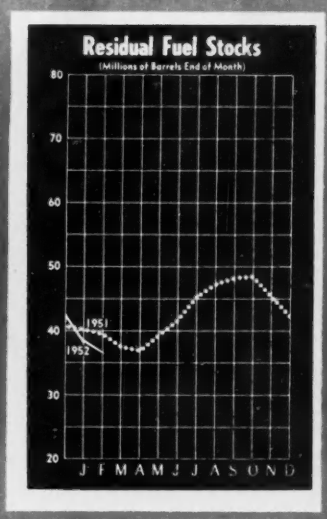
Petroleum

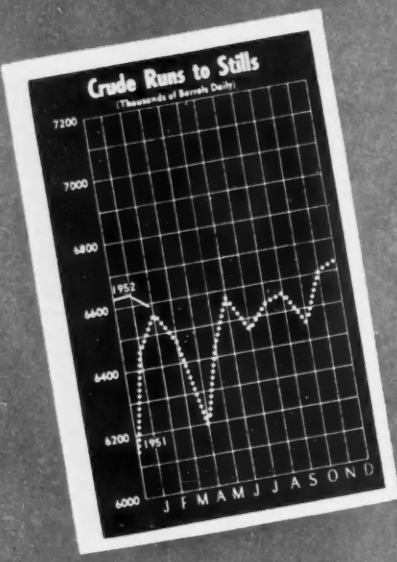
By CECIL W. SMITH,

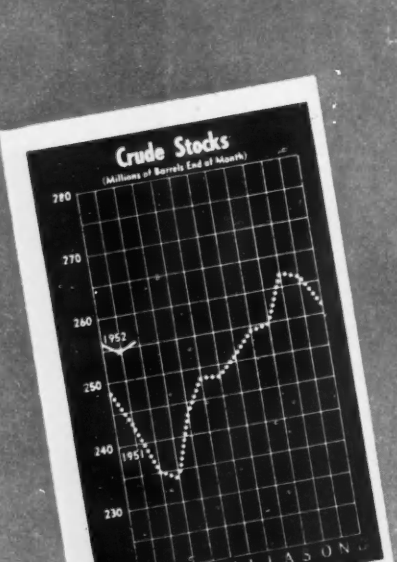












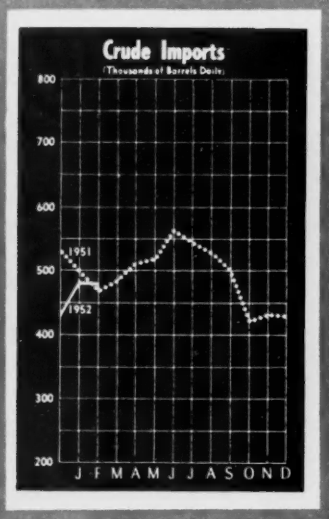
U. S. Crude Production by States

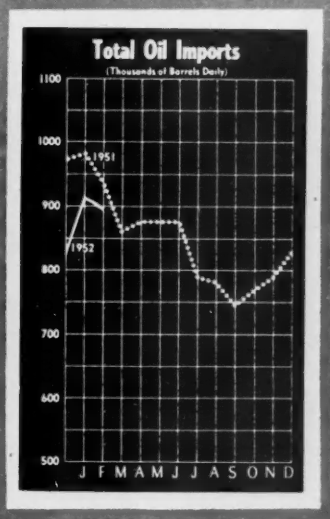
(THOUSANDS OF BARRELS)

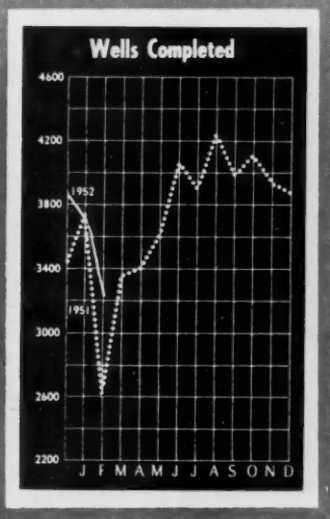
STATE or DISTRICT	DAILY AVERAGE PRODUCTION February, 1952	January, 1952	February, 1951	% Diff. Feb., '51-'52	TOTAL PRODUCTION First Two Months 1952	1951	% Diff. '51-'52
Alabama	2.7	2.8	2.5	+ 8.0	164	153	+ 7.2
Arkansas	80.8	81.9	82.7	— 2.3	4,883	4,837	+ 1.0
California	977.2	980.2	961.9	+ 1.6	58,726	56,662	+ 3.6
Colorado	80.2	80.1	74.7	+ 7.4	4,808	4,403	+ 9.2
Florida	1.7	1.8	1.6	+ 6.3	103	91	+ 13.2
Illinois	163.5	169.7	154.0	+ 6.2	10,004	9,475	+ 5.6
Indiana	29.6	30.5	22.4	+ 32.1	1,805	1,434	+ 25.9
Kansas	320.8	313.0	308.6	+ 4.0	19,007	18,000	+ 5.6
Kentucky	34.9	34.1	26.4	+ 32.2	2,067	1,652	+ 25.1
Louisiana	659.1	655.6	622.0	+ 6.0	39,436	36,911	+ 6.8
North Louisiana	127.9	128.0	120.7	+ 6.0	7,675	7,045	+ 8.9
South Louisiana	531.2	527.6	501.3	+ 6.0	31,761	29,866	+ 6.3
Michigan	37.5	37.6	39.3	— 4.6	2,253	2,342	— 3.8
Mississippi	102.7	102.1	103.8	— 1.1	6,142	6,142	.....
Missouri	0.1	0.1	0.1	.....	4	5	— 20.0
Montana	24.8	25.4	24.7	+ 0.4	1,507	1,434	+ 5.1
Nebraska	6.0	7.1	8.2	— 26.8	395	518	— 23.8
New Mexico	156.2	152.1	137.8	+ 13.4	9,246	8,081	+ 14.4
New York	13.3	13.3	11.3	+ 17.7	799	679	+ 17.7
North Dakota	0.4	0.2	.....	.....	18	.....	.....
Ohio	8.6	8.4	7.7	+ 11.7	511	487	+ 4.9
Oklahoma	518.9	520.2	499.4	+ 3.9	31,175	29,334	+ 6.3
Pennsylvania	28.7	29.1	31.6	— 9.2	1,734	1,903	— 8.9
Tennessee	.....	.....	.....	.....	2	2	.....
Texas	2,910.6	2,758.3	2,607.7	+ 11.6	169,915	152,715	+ 11.3
Dist. 1—South Central	33.1	32.4	32.0	+ 3.4	1,963	1,901	+ 3.3
Dist. 2—Middle Gulf	169.8	159.8	155.4	+ 9.3	9,878	9,153	+ 7.9
Dist. 3—Upper Gulf	498.6	475.6	478.0	+ 4.3	29,204	27,970	+ 4.4
Dist. 4—Lower Gulf-S.W.	266.3	251.1	243.3	+ 9.5	15,509	14,239	+ 8.9
Dist. 4—East Central	62.5	52.3	47.0	+ 33.0	3,433	2,746	+ 25.0
Dist. 6—Northeast	399.2	392.7	380.0	+ 5.1	23,750	22,338	+ 6.3
Dist. 7-B—N. Central	88.4	84.1	77.7	+ 13.8	5,170	4,577	+ 13.0
Dist. 7-C—W. Central	141.9	130.0	86.5	+ 64.0	8,144	5,078	+ 60.4
Dist. 8—West	1,005.3	939.2	866.3	+ 16.0	58,268	50,475	+ 15.4
Dist. 9—North	162.3	157.6	147.3	+ 10.2	9,595	9,000	+ 6.6
Dist. 10—Panhandle	83.2	83.5	89.9	— 7.5	5,001	5,308	— 5.8
Utah	4.0	3.4	3.5	+ 14.3	223	203	+ 9.9
Virginia	0.1	0.1	.....	.....	6	2	+200.0
West Virginia	7.4	7.5	7.3	+ 1.4	447	442	+ 1.1
Wyoming	183.4	180.5	190.8	— 3.9	10,917	11,244	— 2.9
Total United States	6,353.4	6,195.1	5,930.0	+ 7.1	376,297	349,151	+ 7.8

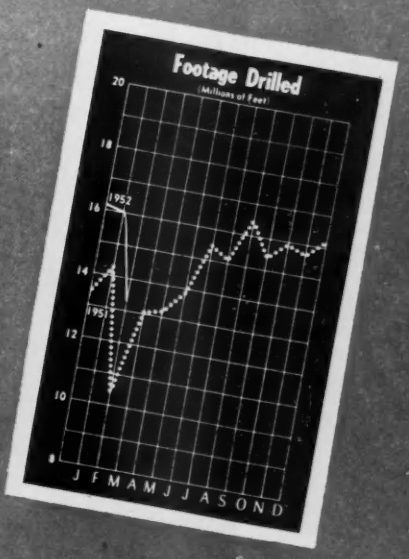
Trends in U. S.

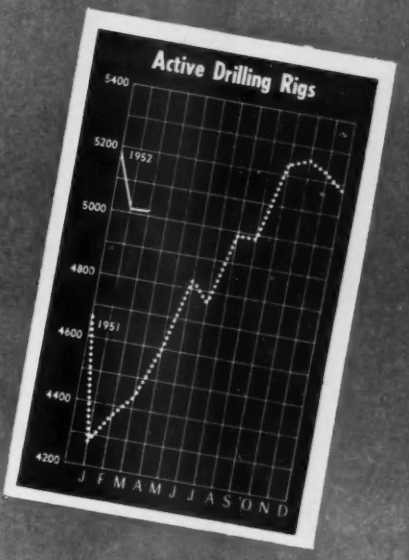
WORLD OIL Staff

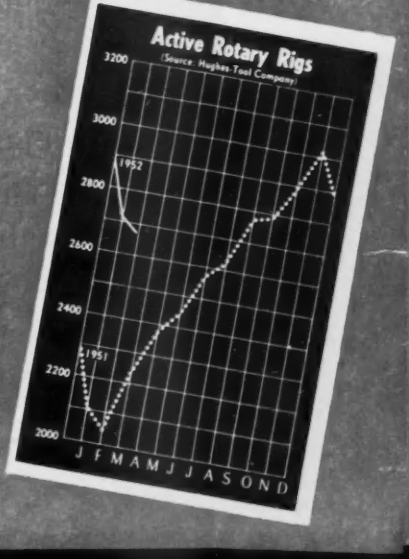








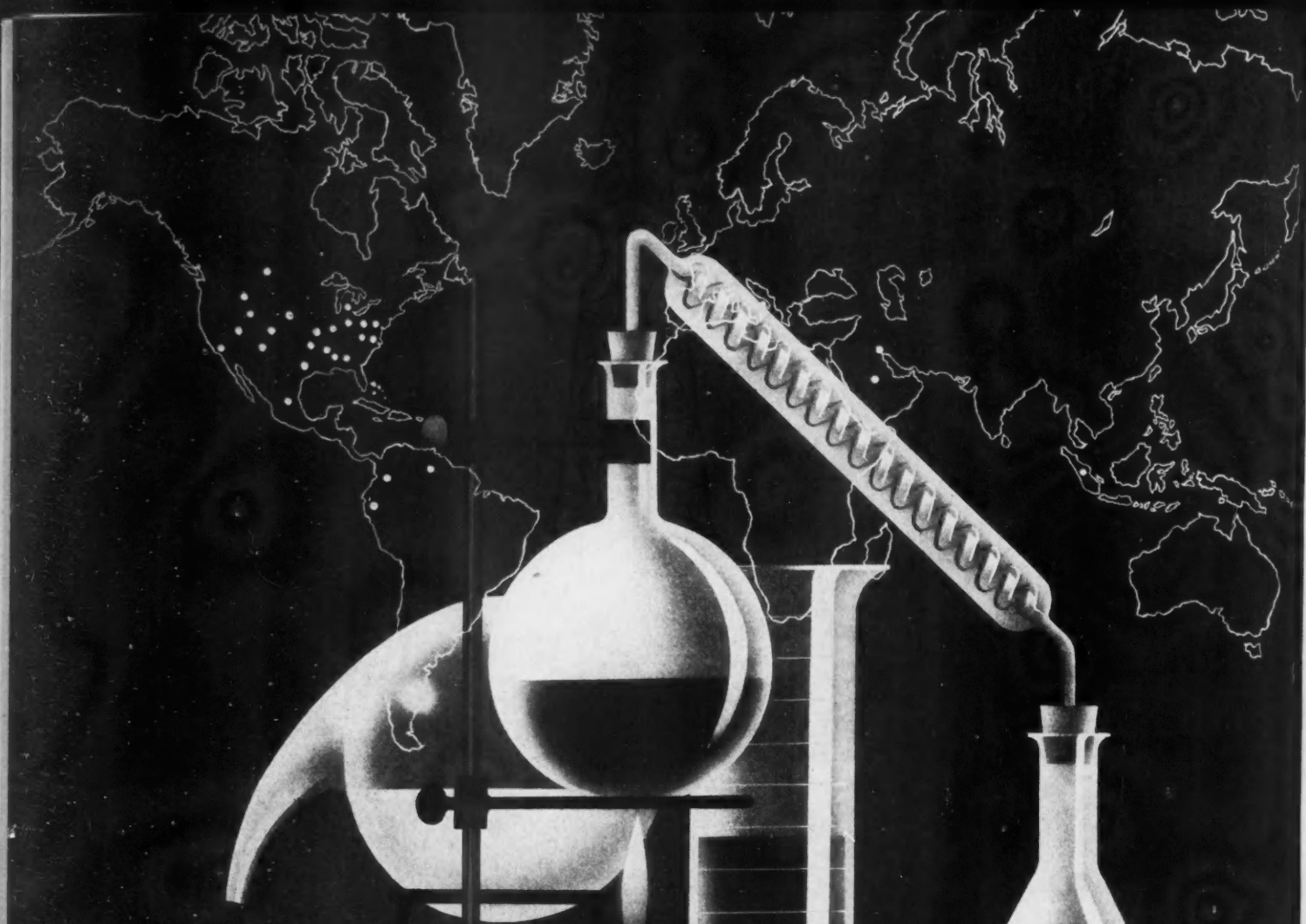




Crude Oil and Refined Products Trends

(THOUSANDS OF BARRELS)

MONTH	CRUDE OIL			GASOLINE		DISTILLATE FUEL		RESIDUAL FUEL		DAILY IMPORTS	
	Production Daily	Runs to Stills Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Crude Oil	Total Oils
1950:											
February..	4,967	5,316	243,750	2,552	132,796	1,026	52,206	1,172	47,828	411	684
March....	4,878	5,336	241,098	2,539	133,766	938	37,777	1,154	41,860	471	869
April.....	4,968	5,193	244,605	2,508	128,057	977	37,530	1,048	39,979	511	888
May.....	5,143	5,535	239,877	2,647	121,035	997	42,739	1,063	39,482	439	766
June.....	5,378	5,655	242,287	2,748	114,074	1,037	53,679	1,069	40,124	498	838
July.....	5,484	5,882	240,270	2,835	111,055	1,040	62,555	1,140	42,165	486	806
August....	5,665	6,067	237,393	2,932	107,067	1,089	68,426	1,148	40,979	501	839
September.	5,888	6,059	242,311	2,849	105,748	1,180	78,270	1,178	41,966	525	859
October...	5,900	6,077	246,424	2,875	105,764	1,217	85,643	1,250	45,004	510	896
November.	5,891	6,085	250,016	2,859	109,005	1,218	86,113	1,240	45,048	466	891
December.	5,719	6,143	248,463	2,879	116,769	1,343	71,948	1,306	40,750	530	974
1951:											
January...	5,907	6,450	243,107	2,962	128,479	1,427	58,424	1,368	40,317	499	977
February..	5,930	6,562	235,247	2,906	137,243	1,419	47,587	1,382	39,409	468	937
March.....	6,052	6,469	233,824	2,908	141,456	1,327	42,978	1,348	37,516	483	861
April.....	6,127	6,183	243,180	2,821	139,188	1,171	44,736	1,230	36,910	511	871
May.....	6,170	6,436	248,418	3,031	132,261	1,210	55,273	1,265	39,317	518	876
June.....	6,130	6,575	248,170	3,100	127,595	1,254	67,839	1,277	41,566	563	876
July.....	6,141	6,462	250,847	3,091	121,482	1,228	79,437	1,275	45,163	546	788
August....	6,232	6,539	254,276	3,114	114,446	1,237	87,432	1,225	47,243	529	780
September.	6,261	6,558	254,900	3,127	114,147	1,282	96,241	1,228	48,212	500	744
October...	6,375	6,446	262,266	3,105	108,800	1,295	102,561	1,224	48,415	421	769
November.	6,272	6,609	261,100	3,130	112,028	1,358	94,917	1,304	45,378	425	802
December.	6,182	6,646	255,783	3,150	124,982	1,442	80,785	1,313	42,063	423	834
1952:											
January...	6,195	6,635	254,346	3,135	135,314	1,433	63,550	1,328	38,261	484	915
February..	6,353	6,595	256,271	3,102	142,641	1,514	52,856	1,309	36,537	476	891
Feb., 1952 Change:											
In Month	+158	—40	+1,925	—33	+7,327	+81	—10,694	—19	—1,724	—8	—24
In Year	+423	+33	+21,024	+196	+5,398	+95	+5,269	—73	—2,872	+8	—46
Week Ended:											
3-15-52...	6,306	6,693	253,111	3,108	146,165	1,460	47,972	1,283	36,054	471	834
3-17-51...	6,043	6,382	233,115	2,906	141,007	1,256	44,966	1,353	37,753	560	880



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Monthly News Analysis

Washington Developments Shaping Industry Outlook

Washington developments are pointing toward a further rise in oil industry operating costs.

This will be reflected first in the near future as a result of the government-backed move to bow to labor demands for a "seventh round" wage hike. It is starting as in the past with the Wage Stabilization Board proposal "package" increase of 22½ cents an hour to the CIO United Steelworkers Union to be spread over a period of a year, starting with last January. As proposed late in March, over the vigorous objections of industry representatives, the hikes will be the largest in the postwar period.

Steel industry officials, already promised a $2 to $3 a ton raise in steel prices under the Capehart Amendment to cover increased costs incurred in the period from June, 1950, to July, 1951, say the industry will have no recourse but to request a further price increase to cover the costs of such a substantial wage boost.

Aside from the almost immediate jump in costs to oil and gas operators resulting from higher steel prices, a not-too-far-distant additional possible increase in costs exists in the demands of the CIO Oil Workers International Union for a higher wage hike than the 9 to 10 cents an hour permitted by WSB regulations and offered by oil companies. While this increase is labeled principally for refinery workers, in the long-run it would include production and pipe line employes.

A conclusion can be readily drawn that the benefits given one CIO union with a strong government assist will be sought by other unions of the group, since union leader's prestige will be considered a more important factor than the economic ills that may befall a rank and file member called out on strike to support the union's demands.

While some independent refinery unions have settled for the company-offered wage increase and some oil field employes previously received wage adjustments, the pressure for additional boosts will be strong if, through federal mediation or other government machinery, the OWIU should manage to gain benefits above the levels now authorized under WSB rules.

With the wage board chairman, Nathan P. Feinsinger, describing the steel pay hike "in all respects fair and equitable," concessions circumventing the intent of the Truman Administration sponsored economic controls can be expected, though little, if anything, appears certain on the other side of the ledger to permit offsetting concessions to industry.

After June 30, What?

Among the more important uncertainties that probably will continue to exist during the next three months is the form of government controls over the nation's economic life. The defense Production Act of 1950 as amended last year, which sets the pattern with respect to all business operations, expires June 30. While spokesmen from nearly every industrial group have appeared before Senate and House committees studying the possible extension of the present law, the Administration insists continued economic controls are necessary to prevent further inflation.

A continuation of present price controls in the Defense Production Act would contain one certainty: Crude oil prices would remain for a long time a non-inflationary factor unless, over Administration objections, decontrol provisions could be written into the extended law. One such provision, directly applicable to crude oil, has been introduced by Rep. Omar Burleson of Texas.

The Administration's argument that controls are needed to prevent inflation appears out of line with the view of the WSB chairman that higher steel wages will not cause another inflationary round of increases and with the statements of Defense Production Administration officials that the present Controlled Materials Plan can be scrapped by the start of 1953. There are hints from the agency, which controls allotments of essential metals to industry, that allocation of most types of carbon steel may be ended before the close of this year.

As a start in the direction of decontrol of steel, DPA has indicated it will increase allocations of steel to the petroleum industry to near the level requested by Petroleum Administration for Defense, starting with the third quarter of this year. This is in line with PAD's recommendations for an 18-month development program to step up steel supplies by 45.9 percent to domestic operators, 42 percent to Canadian operators, and 36 percent to other foreign countries over the volume allocated from July, 1951, through June, 1952. This program, as outlined in the March issue of World Oil, calls for drilling of 80,000 wells in the U.S. in the 18-month period starting with July 1 and 10,128 new wells abroad, of which 4050 would be in Canada. Also included in the program would be additional steel for a broader pipe line, refinery and storage construction program. Final approval of such an expanded program hinges on uninterrupted steel mill operations.

DPA Grants Permission for Industry Expansion Program

Petroleum Administration for Defense received approval of the Defense Production Administration to proceed with most of its requested expansion program for the oil and gas industry, to be spread over an 18-month period starting with July 1.

To start the stepped-up industry program, DPA has issued a third quarter steel allotment for distribution to the domestic industry of 1,903,750,000 tons, the largest quarterly allocation to PAD since the controlled materials plan commenced last July. While under the 2,300,000 tons requested by PAD for the three months starting with July, the new allotment is nearly 200,000 tons greater than allocated for domestic and foreign industry operation for the April-June period. DPA characterized the third quarter allocation as sufficient "to carry forward the revised petroleum program at a high level." The agency stated other allotments will permit expansion of foreign pe-

troleum facilities "at about the same rate."

PAD's requested program was to permit drilling of 80,000 new domestic wells in the 18 months starting with the third quarter, 25,000 of which would be completed in 1952 and 55,000 in 1953. DPA reportedly suggested a domestic drilling program next year of a maximum of 53,000 new wells, though it is expected PAD will seek to have its full drilling program realized. Steel allocations to the domestic industry for the first half of this year have been at a programmed level to assure drilling of about 44,000 wells.

DPA also has suggested to PAD that the latter's proposed domestic refinery expansion program be increased to an annual rate of adding 500,000 barrels daily of new capacity in place of the PAD recommendations for an annual rate of 475,000 barrels daily, or 712,500 barrels daily of new capacity over an 18-months period. PAD stated that upon final approval of the DPA-suggested increased refinery expansion program, it will resume recommending new basic refinery projects for rapid tax amortization. PAD has a backlog of projects which would add 400,000 barrels daily of basic refining capacity ready to send to DPA for rapid tax write-off certification.

Third quarter allocation to the domestic industry also includes 9,050,000 pounds of copper, compared with 8,375,000 pounds for second quarter, and 1.5 million pounds of aluminum, compared with 1.3 million pounds for the second quarter.

Demand Up 9.6 Percent for 1951, Says Bureau Report

A complete report of petroleum supply and demand in 1951 by the Bureau of Mines indicates demand for all oils for the year averaged 7,467,000 barrels daily, an increase of 9.6 percent over 1950. Domestic demand for all oils averaged 7,043,000 barrels per day, up 8.2 percent, and export demand jumped 39 percent to an average of 424,000 barrels daily.

Total new supply of crude oil and liquid hydrocarbons averaged 7,556,000 barrels daily, of which 6,713,000 barrels a day represented domestic production and 843,000 barrels daily were imported crude oil and refined products. Daily average domestic crude oil output amounted to 6,149,000 barrels. Crude refinery runs for the year averaged 6,494,000 barrels daily for the year, an increase of 13.2 percent over 1950.

NPC Statement Spikes Reports Of Diminishing Oil Supplies

One of the strongest testimonials yet to the competitive free enterprise system of operations in the petroleum industry is in the report of the National Petroleum Council on future availability of oil and gas throughout the world.

The comprehensive study of the council's Committee on Oil and Gas Availability pays tribute to the striking accomplishments of private capital enterprises in providing the free world with increased supplies of liquid petroleum fuels. Projecting these achievements over the short and long-term future, the report concludes that:

> **"The U. S. and the world can count upon increasing supplies of oil and gas, not only for the next few years but for the foreseeable future, provided that reasonable economic incentive, adequate materials, and a favorable climate for private investment prevail."**

The intensive study by hundreds of experts in the industry serving on the committee headed by L. F. McCollum, president of Continental Oil Company, indicates beyond any doubt that there is no foundation to recurring rumors that petroleum resources in the U. S. and the world are in any way diminishing.

Data compiled by the committee indicate that availability of all oils in the U. S., under maximum efficient rates of production and at current drilling rates, is expected to rise from 7,300,000 barrels daily in January, 1951, to a range of between 7,789,000 and 8,838,000 barrels daily by 1955.

Corresponding figures for all areas outside the U. S., exclusive of the Russian orbit, indicate expected availability by 1955 of between 6,669,000 and 7,427,000 barrels a day, compared with a January, 1951, daily average availability of 4,703,000 barrels. Combined world total productive capacity, according to the committee's estimates, by 1955 would range between 14,458,000 and 16,265,000 barrels, compared with a January, 1951, availability of 12,003,000 barrels per day.

Over-all, the committee estimates the availability of petroleum liquids in 1955 will be higher than January, 1951, production by not less than 1,324,000 barrels daily in the U. S. and 2,171,000 barrels daily in foreign areas outside the Iron Curtain. This minimum increase is almost equal to the increase in production from 1946 to January, 1951, and under favorable conditions, availability in 1955 may run higher, amounting to an increase of more than 5,300,000 barrels per day.

Assuming continuation of exploration and producing activities abroad without interruption, the study indicates productive capacity in areas outside the U. S. will rise at a faster rate than estimated domestic availability, with the Eastern Hemisphere accounting for the largest increase. Based on these predicted trends, the U. S. share of total petroleum availability by 1955 is expected to be no larger than 54.3 percent, compared with a minimum of 58.6 percent in 1951. Actual U. S. production in 1951 amounted to 52.73 percent of the world total, according to a tabulation by WORLD OIL.

Despite the optimism of foreign petroleum availability in the near future, the committee noted in its 105-page report: "The principal risk which may lie ahead for the U. S. in continuing to rely on crude oil supplies is in becoming unduly dependent upon foreign sources that might be cut off suddenly." The degree of accessibility of foreign oil in case of emergency, it continued, will be of paramount importance.

Non-Working Tubular Goods Stocks Allowed for by PAD

Provision has been made for the deduction of "non-working" stocks of oil country tubular goods from inventory in Petroleum Administration for Defense calculations of the 90-day working inventory of oil and gas operators applying for priorities assistance.

Heretofore operators in stating inventory have been required to list all unused materials, including pipe that may have been purchased for special operations in the past, but that might not be reasonably usable in current drilling programs. Inclusion of such materials in required reports of inventory for calculation of future allotments of tubular goods has resulted in denying some operators a working supply suitable for quarterly drilling schedules.

The new system permits deduction of "non-working" items providing such are reported on regular PAD-16

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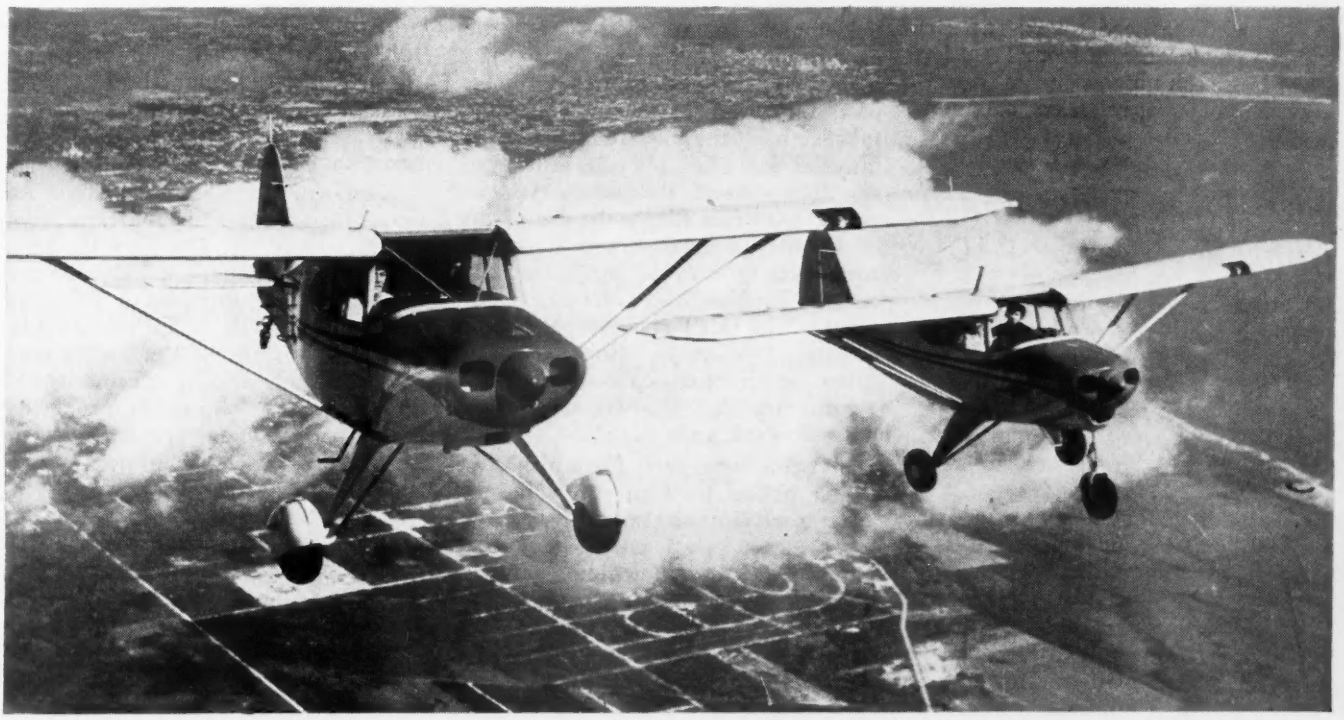

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forms, showing tonnage, size, weight, grade, specification and location, and agreement is made in writing to PAD that: (1) an operator will effect trade of such pipe when feasible; (2) will sell such materials to other operators with immediate need for it; and (3) will obtain permission from PAD before using such pipe in current operations after it is reported as "non-working" stock.

House Group Finds No Fault With Allocations by PAD

Petroleum Administration for Defense was given a clean bill of health by the House Small Business Committee in a report of its investigation of the agency's allocation and distribution of oil country tubular goods to the industry. The report stated that while PAD had made some mistakes during its operating period, the committee found no evidence of favoritism or actions dictated by self-interest.

The conclusion reached was that PAD has consistently attempted to allocate oil country tubular goods fairly and impartially within the limitations imposed by a formula which, of necessity, had to be developed by trial and error. Policies of Defense Production Administration, which controls total allocations of controlled materials to all industrial, commercial and military groups, were also approved as they related to allocations of tubular goods to PAD for distribution to users.

Steel Supplies to Permit More West Canada Drilling

Steel supplies are expected to be sufficient, barring a strike of the U. S. industry or a total war, to permit a greatly expanded Western Canadian oil development program during 1952, according to estimates of Ralph W. Will, director of the petroleum division of the Canadian Department of Defense Production. The estimates anticipate 1850 new wells in 1952 compared with 1400 in 1951.

The estimates of drilling in the Prairie Provinces are based on the present rate of steel availability allocated to the Canadian industry by the Petroleum Administration for Defense and imports from foreign sources. This does not include the increased rate of drilling that might result from the PAD-proposed sharp increase in oil country tubular goods to both U. S. and foreign operators expected to start with the third quarter of this year.

IPAA Issues New Demands for Removal of Price Controls

Demands for removal of controls over crude oil and natural gas prices have been directed to two branches of the government with authority to take action—the executive and legislative. These consisted of a request by the Independent Petroleum Association of America filed with the Office of Price Stabilization and testimony presented by the association to the Senate Banking and Currency Committee. The latter conducted hearings on the Truman Administration request for an extension of the Defense Production Act beyond its present June 30 expiration date.

While some early form of positive action by Congress will be required to maintain price controls after July 1, past experience indicates no immediate action can be expected through appeals to OPS officials. The recent OPS decision to permit a 7 cents a barrel hike in ceiling prices for Spraberry crude to a top of $2.65 a barrel for 40-gravity and above to bring the price of this production in line with crude of the same quality in the same area of Texas came after a year's effort by Spraberry producers for price relief.

Citing the necessity of fulfilling the expanded development program outlined by Petroleum Administration for defense to take effect with the second half of this year, Russell B. Brown, IPAA general counsel, stated to both OPS and the Senate committee that such a program can be accomplished only when the inequities of present price controls have been removed. Under the expanded PAD program to drill at an annual rate of 50,000 wells starting in July, IPAA estimated total income from crude production this year based on the February average price of $2.56 a barrel would approximate $5940 million. The IPAA estimated minimum income from crude required to meet this expanded program at $6910 million, or a minimum price of $2.98 a barrel based on estimated 1952 production of 2320 million barrels.

Projecting these minimums to 1953 to meet a PAD-proposed required drilling program of 55,000 wells, IPAA said estimated income from crude based on present prices would be $6250 million, while estimated minimum required income would be $8 billion, or a required minimum price of $3.28 a barrel, assuming a 1953 output of 2440 million barrels. Neither the 1952 nor the 1953 estimates of minimum income required provides for increased costs or higher taxes that may be incurred.

Support for price decontrol has come from numerous representatives of other industries and from the U. S. Chamber of Commerce. Also, Representative Omar Burleson of Texas has introduced a bill in the House proposing to amend the Defense Production Act by providing specific legislative standards for mandatory decontrol of prices whenever a test of the standards is met. As it now stands, exemptions from price controls are permissible under the Defense Production Act, but the provision is discretionary with OPS. In introducing his bill, Burleson used crude oil as a specific example of the condition aimed at by his bill. He stated present frozen prices are leading to the situation that occurred during World War II price controls, when the annual rate of drilling lagged far behind the actual needs of new wells to find crude supply to replace the volume produced.

New Firm Doing Exploratory Work in Western Australia

West Australian Petroleum Proprietary, Ltd., a new company formed by AMPOL, an Australian organization, and California Texas Oil Company, Ltd., has begun exploratory operations in Western Australia. Holding permits from the Western Australia government to prospect more than 350,000 square miles of desert country, AMPOL has completed much preliminary geological work. The permits are being transferred to the new company.

Caltex has assumed a preliminary commitment of $3 million which will be spent, if necessary, prior to the initial test. Though the site of the first well has not been selected, it probably will be about 800 miles north of Fremantle or 200 miles north of Carnarvon. Drilling equipment capable of reaching 15,000 feet will be used.

The 350,000 square miles over which prospecting permits are held extend, generally, along the coast from the eastern boundary of the state of Western Australia to its southwest tip.

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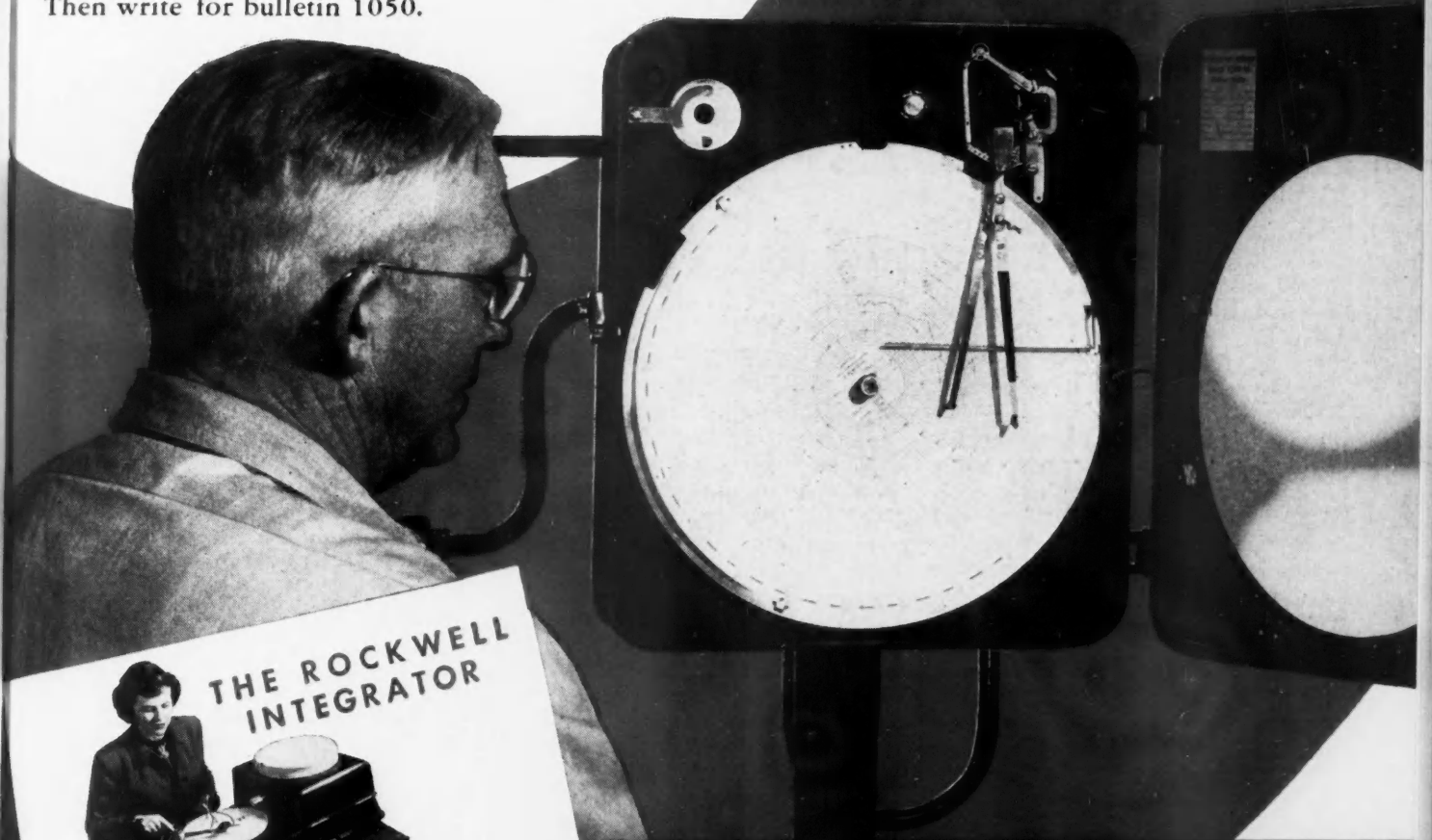

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Completions Up 8 Percent As Drilling Continues Brisk

THE high rate that marked the opening of this year's drilling activity was continued during February, and the number of wells completed in the first two months of this year led last year's by almost 8 percent. Current deeper drilling resulted in footage drilled topping the previous period's by a substantially greater margin.

February's 3249 wells and January's 3745 totaled 6994 for the year, and that was 7.9 percent more than the 6479 recorded in the same period of 1951. But that comparison is only part of the story. When well numbers alone are compared, little indication of the effort is obtained. The truer measure of the industry's activity is found by comparing amounts of hole drilled.

Here is found a gain of 18.1 per cent in the amount of footage drilled this year over than recorded in last year's first two months. On the average, each new well has been 4203 feet deep, while a year before the average was bottomed at 3868 feet.

More than half of the U. S. gain in wells completed was accounted for by Texas, the leading drilling state. The nation as a whole saw 515 more wells drilled in the first two months than in the comparable period of 1951, and Texas alone furnished 293. Texas' wells were up 10.9 percent, but total footage drilled in the state was hiked 27.3 percent. Oklahoma, the No. 2 drilling state, showed a smaller 3.7 percent gain in completed wells, and Kansas continued to occupy third position with a drilling increase of 12.1 percent.

California and Louisiana increased their activity over last year by 16.2 and 14.4 percent, respectively. Both Wyoming and Montana, in the Rocky Mountain region, lowered drilling rates slightly, but Colorado showed the greatest percentage increase in the nation. Its 64 completed wells represented a gain of 106.5 percent over the 31 recorded in last year's first two months. Wyoming and Montana's declines amounted to 7.5 and 7.4 percent, respectively.

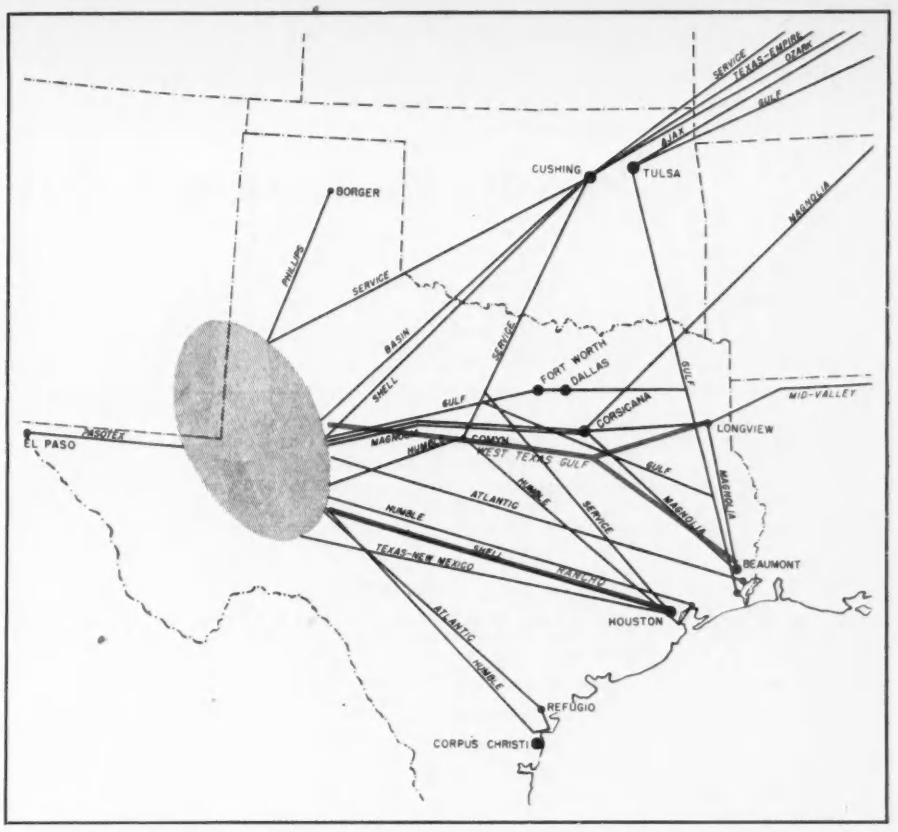
Well Completions in the United States During February, 1952, and First Two Months, 1952

(Figures compiled by WORLD OIL Staff from private reports and other sources as follows: Illinois from Illinois Geological Survey; Indiana from Indiana Division of Geology; Missouri from Missouri Geological Survey; Tennessee from Tennessee Division of Geology; Bradford, Kane-Clarendon and Allegany fields of Pennsylvania and New York from the "Producers Monthly.")

State or District	MONTHLY COMPLETIONS, FEBRUARY, 1952									TOTAL COMPLETIONS				CUMULATIVE TOTALS January-February					Rigs in Operation (Drilling, Rigging-Up and Shut Down)		
	NEW WELLS																				
	Oil	Dist.	Gas	Dry	Water Input	Gas Input	Water Disposal	Total New	Total Drilled Deeper	Feb., 1952	Jan., 1952	Feb., 1951	Footage Feb., 1952	Wells 1952	Wells 1951	Percent Diff.	Footage 1952	Footage 1951	Feb. 29, 1952	Jan. 31, 1952	Feb. 28, 1951
Alabama			1	3				4		4	3	4	23,350	7	11	— 36.4	34,065	51,414	6	5	6
Arizona															1	—100.0		3,640	2	2	3
Arkansas	16		2	7				25	1	26	30	18	107,444	56	52	+ 7.7	218,753	180,178	33	27	30
California	143	1	2	49				195	12	207	209	160	743,512	416	358	+ 16.2	1,609,931	1,332,049	255	265	227
Colorado	18		1	16				35		35	29	14	194,531	64	31	+106.5	355,882	146,951	33	33	17
Florida				1				1		1			11,794	1			11,794			1	1
Idaho												1			1	—100.0		12,844	1	1	
Illinois	43			52				95		95	112	133	220,180	207	305	— 32.1	495,514	740,047	169	185	155
Indiana	20			24				44		44	58	45	78,349	102	142	— 28.2	187,286	249,367	144	169	202
Kansas	154		13	135			5	307		307	350	288	1,071,738	657	586	+ 12.1	2,292,913	1,984,494	413	419	341
Kentucky	30		15	34				79		79	78	66	160,578	157	157		318,966	312,149	88	84	89
Louisiana	80	5	12	48				145		145	213	117	977,959	358	313	+ 14.4	2,330,740	2,204,911	238	222	204
North Louisiana	39	1	11	23				74		74	129	50	273,252	203	136	+ 49.3	782,773	524,005	61	59	75
South Louisiana	41	4	1	25				71		71	84	67	704,707	155	177	— 12.4	1,547,967	1,680,906	177	163	129
Maryland			4					4		4	4	1	16,402	8	3	+166.7	32,546	10,797	25	24	10
Michigan	16		1	30				47		47	36	46	120,067	83	86	— 3.5	227,151	211,669	115	113	108
Mississippi	13			21				34		34	37	15	242,955	71	38	+ 86.8	517,314	258,920	27	29	31
Missouri	1			1				2		2	1		4,437	3			4,539		6	6	5
Montana	5		1	7				13		13	12	8	38,426	25	27	— 7.4	75,743	58,335	37	39	22
Nebraska	4			2				6	1	7	22	7	32,202	29	17	+ 70.6	143,817	78,001	14	7	11
Nevada												1			1	—100.0		10,314	1	1	2
New Mexico	39		20	18				77	1	78	83	44	411,979	161	103	+ 56.3	826,397	504,108	169	179	125
New York	38				25			63		63	46	38	88,037	109	72	+ 51.4	153,393	100,166	73	56	75
North Dakota	1							1		1			8,595	1			8,595		13	14	2
Ohio	14		12	27				53		53	67	41	132,044	120	127	— 5.5	278,972	275,304	144	147	128
Oklahoma	251	2	26	181	10		3	473	10	483	488	315	1,786,654	971	936	+ 3.7	3,548,331	3,439,622	608	639	545
Pennsylvania	45		17	3	43	4		112	1	113	106	78	208,288	219	189	+ 15.9	383,394	343,672	219	222	217
South Dakota																			2	2	
Tennessee																			7	8	6
Texas	729	13	48	484	4	1	1	1,280	8	1,288	1,693	1,119	5,953,148	2,981	2,688	+ 10.9	14,337,846	11,262,314	1,862	1,828	1,482
Dist. 1 S. Central	21		1	39			1	62		62	54	37	175,281	116	101	+ 14.9	345,142	249,642	42	35	43
Dist. 2 Middle Gulf	19	2	11	32				64		64	71	37	380,853	135	116	+ 16.4	853,562	647,957	68	62	56
Dist. 3 Upper Gulf	76	5	7	35				123		123	179	92	802,540	302	232	+ 30.2	1,982,618	1,387,761	162	148	128
Dist 4 L. Gulf-S.W.	69	5	4	49				127		127	153	107	619,331	280	244	+ 14.8	1,418,608	1,230,533	113	104	120
Dist. 5 E. Central	16		1	9				26		26	40	40	134,791	66	68	— 3.0	341,948	255,765	30	25	34
Dist. 6 Northeast	24	1	8	13				46		46	50	41	304,851	96	99	— 3.0	629,062	496,279	50	52	33
Dist. 7-B N. Cent.	96		1	110				207		207	219	176	656,239	426	384	+ 10.9	1,347,921	1,040,621	184	170	175
Dist. 7-C W. Cent.	91			41				132	1	133	231	89	770,950	364	203	+ 79.3	2,146,296	804,627	289	250	131
Dist. 8 West	172			46				218	6	224	380	268	1,260,019	604	634	— 4.7	3,409,036	3,408,206	517	563	432
Dist. 9 North	138		5	110	4	1		258	1	259	258	196	799,719	517	451	+ 14.6	1,611,025	1,267,509	288	295	237
Dist. 10 Panhandle	7		10					17		17	58	36	48,574	75	156	— 51.9	252,628	473,414	129	124	93
Utah	1			6				7		7	2	3	42,002	9	5	+ 80.0	53,569	13,537	28	25	11
Virginia																			1	1	1
West Virginia	11		49	5				65		65	27	62	185,107	92	136	— 32.4	261,531	394,438	201	181	205
Wyoming	29	1		17				47	1	48	39	45	242,770	87	94	— 7.5	433,012	492,556	81	76	78
Total U. S.	1,701	22	224	1,171	82	5	9	3,214	35	3,249	3,745	2,669	13,102,548	6,994	6,479	+ 7.9	29,141,994	24,671,797	5,015	5,010	4,339

OUT OF the Permian Basin of West Texas and southeast New Mexico, which produces a fifth of all U. S. oil production, 941 miles and $74 million worth of new crude pipe lines will be laid this year to ease refinery oil shortages on the Gulf Coast, Atlantic seaboard and in the Great Lakes area. Designed for an ultimate throughput of 615,000 barrels of oil daily, the West Texas Gulf Pipe Line Company and Rancho Pipe Line System lines may enable the PAD-estimated MER allowables to be moved. Heretofore, there have been insufficient facilities for transporting West Texas' abundant production to proper markets. These lines will go far toward achieving this end.

By DON KLIEWER
WORLD OIL Staff



Upon completion of West Texas Gulf and Rancho pipe lines, this vast crude transportation network will be capable of moving more than 1,600,000 barrels of oil daily out of West Texas' Permian Basin.

Permian Basin to Points South—and East

New Crude Lines to Ease Supply Problem

A SALUTARY effect on West Texas oil production, including marginal leases, and the refinery oil-short Gulf Coast will result from 941 miles of new crude lines scheduled for completion this year. Quick to approve both West Texas Gulf Pipe Line Company and Rancho Pipe Line System lines, Petroleum Administration for Defense dipped deep into its store of federally-controlled line pipe to effect in these abnormal times what the oil industry itself would have accomplished in a normal period.

While affording additional possible outlets to fringe areas which can be served economically and alleviating West Texas' unfailing storage problem, West Texas Gulf's 372-mile, 26- and 24-inch pipe line from Colorado City to Beaumont, and 114-mile 20-inch line from Wortham to Longview; and Rancho System's 455-mile, 24-inch line from McCamey, Upton County, to Deer Park, Harris County, will assure West Texas producers that major oil companies will not request a change from the Texas Railroad Commission's across-the-board policy that all Texas fields which can make their MER allowables be given the same number of producing days.

Equal Basis

In other words, West Texas will find itself in a position to produce more oil and on the same basis as other Texas fields. Currently, MER for West Texas, the Panhandle and New Mexico areas is estimated at 1,618,000 barrels a day. PAD estimates that 400,000 barrels daily of additional pipe line construction will be required to move the full amount to market. This, then, is the function of the scheduled lines, whose total capacity will eventually reach 615,000 barrels a day.

Heretofore, transportation was a serious bottleneck, but these lines will relieve present systems and provide greater and much-needed flexibility. Where West Texas and New Mexico crude movement was governed by space requirements, the present systems will have greater capacity to transport crude to waiting northern markets and the added lines will provide for movement to the east and Gulf Coast.

These two new systems, to cost approximately $74 million, lend further emphasis to West Texas. They are two more steps toward the even greater role West Texas will play in the industry.

This construction will encourage further development because the lines will furnish a market for the oil and a buffer against possible future cutbacks in production in the areas they serve. A favorable impact is expected on the broad Spraberry trend, which

■ CONTINUED ON PAGE 60

Reserves Increase Relatively Less Than P

Estimated Proved U. S. Reserves of Crude Oil, Natural Gas Liquids, and Total Liquid Hydrocarbons, By Years

Sources: Crude oil by API; natural gas liquids by API and AGA

(THOUSANDS OF BARRELS)

	NEW OIL ADDED DURING YEAR					
	Through Revisions of Previous Estimates and Extensions, to Known Fields	Through Discoveries of New Fields and of New Pools in Old Fields	Total Through New Discoveries, Extensions and Revisions (Columns 1 + 2)	Production During Year	Estimated Proved Reserves as of End of Year (Column 3 — 4)	Increase Over Previous Year
	(1)	(2)	(3)	(4)	(5)	(6)
Crude Oil (Incl. Cycle Plant and Lease Condensate)						
1936					13,063,400	
1937	2,792,790	928,742	3,721,532	1,277,664	15,507,268	2,443,868
1938	2,243,571	810,493	3,054,064	1,213,186	17,348,146	1,840,878
1939	2,058,455	340,667	2,399,122	1,264,256	18,483,012	1,134,866
1940	1,607,012	286,338	1,893,350	1,351,847	19,024,515	541,503
1941	1,538,989	429,974	1,968,963	1,404,182	19,589,296	564,781
1942	1,618,925	260,051	1,878,976	1,385,479	20,082,793	493,497
1943	1,202,368	282,418	1,484,786	1,503,427	20,064,152	(—) 18,641
1944	1,556,192	511,308	2,067,500	1,678,421	20,453,231	389,079
1945	1,690,315	419,984	2,110,299	1,736,717	20,826,813	373,582
Crude Oil Only						
1944					19,784,530	
1945					19,941,846	
1946	2,413,628	244,434	2,658,062	1,726,348	20,873,560	931,714
1947	2,019,140	445,430	2,464,570	1,850,445	21,487,685	614,125
1948	3,398,726	396,481	3,795,207	2,002,448	23,280,444	1,792,759
1949	2,297,428	890,417	3,187,845	1,818,800	24,649,489	1,369,045
1950	1,997,769	564,916	2,562,685	1,943,776	25,268,398	618,909
1951	4,024,698	389,256	4,413,954	2,214,321	27,468,031	2,199,633
Natural Gas Liquids (Condensate, Natural Gasoline and Liquefied Petroleum Gases)						
1946					3,163,219	
1947	192,237	59,301	251,538	160,782	3,253,975	90,756
1948	405,874	64,683	470,557	183,749	3,540,783	286,808
1949	294,211	92,565	386,776	198,547	3,729,012	188,229
1950	707,879	58,183	766,062	227,411	4,267,663	538,651
1951	648,497	75,494	723,991	267,052	4,724,602	456,939
Total Liquid Hydrocarbons (Crude Oil and Natural Gas Liquids)						
1946					24,036,779	
1947	2,211,377	504,731	2,716,108	2,011,227	24,741,660	704,881
1948	3,804,600	461,164	4,265,764	2,186,197	26,821,227	2,079,567
1949	2,591,639	982,982	3,574,621	2,017,347	28,378,501	1,557,274
1950	2,705,648	623,099	3,328,747	2,171,187	29,536,061	1,157,560
1951	4,673,195	464,750	5,137,945	2,481,373	32,192,633	2,656,572

Estimated U. S. Reserves of Natural Gas, By Years

Source: American Gas Association

(Millions of Cubic Feet—14.65 psia, at 60° F.)

	NATURAL GAS ADDED DURING YEAR						
YEAR	Extensions and Revisions	Discoveries of New Fields and New Pools in Old Fields	Total of Discoveries, Revisions and Extensions	Net Change in Storage	Net Production During Year	Estimated Proved Reserves as of End of Year	Increase Over Previous Year
1945						147,789,367	
1946	*	*	17,729,152	*	4,942,617	160,575,901	12,786,535
1947	7,570,654	3,410,170	10,980,824	*	5,629,811	165,926,914	5,351,013
1948	9,769,483	4,129,089	13,898,572	51,482	6,007,628	173,869,340	7,942,426
1949	8,061,429	4,612,870	12,674,299	82,746	6,245,041	180,381,344	6,512,004
1950	9,172,381	2,877,351	12,049,732	54,301	6,892,678	185,592,699	5,211,355
1951	13,013,606	3,039,385	16,052,991	132,751	7,966,941	193,811,500	8,218,801

* Not estimated.

ALTHOUGH U. S. reserves of petroleum and natural gas were increased by relatively large amounts in 1951, the increases were not proportional to the sharp gains in production. Consequently, the ratios of reserves to latest annual rates of production were lower at the end of 1951 than at the end of 1950. On the basis of failure to maintain ratios of reserves to production at unchanged levels, there were reserve-proving deficiencies in 1951 amounting to 1,614,118,000 barrels for total liquid hydrocarbons, 1,318,142,000 barrels for crude, and 295,976,000 barrels for natural gas liquids.

CONTINUED difficulty during 1951 in developing new reserves on the gigantic scale required by ever-increasing production is revealed in figures on U. S. petroleum and natural gas reserves released March 12 by The American Petroleum Institute and the American Gas Association.

Though record drilling and wildcatting proved up more oil reserves than ever before and the second largest annual amount of natural gas, production of all these resources increased so sharply in 1951 above 1950 rates that reserves were not expanded proportionately. Consequently, the ratio of reserves to the latest annual rate of production was lower at the end of 1951 than at the close of 1950 for crude, natural gas liquids, and natural gas.

Total U. S. reserves of liquid hydrocarbons at the end of 1951, estimated at 32,192,633,000 barrels, were only

Production

By L. J. LOGAN

WORLD OIL Staff

13.0 times greater than annual production at the 1951 record rate of 2,481,373,000 barrels. The corresponding reserves of 29,536,061,000 barrels at the end of 1950 had been 13.6 times the annual production of 2,171,187,000 barrels in 1950. If reserves had been kept consistently 13.6 times as great as the rising annual production, they would have had to total 33,806,751,000 barrels at the end of 1951, instead of the 32,192,633,000

Summary of Changes in 1951 in Proved U. S. Reserves of Crude Oil, Natural Gas Liquids, and Total Liquid Hydrocarbons.

Source: Crude oil from American Petroleum Institute; natural gas liquids from API and American Gas Association.

(THOUSANDS OF BARRELS)

CRUDE OIL		
Total proved reserves as of Dec. 31, 1950		25,268,398
Revisions of previous estimates	+1,776,110	
Extensions of old pools	2,248,588	
New reserves discovered in 1951 in new fields and in new pools in old fields	389,256	
Proved reserves added in 1951		4,413,954
Total proved reserves as of Dec. 31, 1950 plus new proved reserves added in 1951		29,682,352
*Less production during 1951		2,214,321
Total proved reserves as of Dec. 31, 1951		27,468,031
Increase in reserves during 1951		2,199,633
NATURAL GAS LIQUIDS		
Total proved reserves as of Dec. 31, 1950		4,267,663
Revisions of previous estimates and extensions of old pools	+648,497	
New reserves discovered in 1951 in new fields and in new pools in old fields	75,494	
Proved reserves added in 1951		723,991
Total proved reserves as of Dec. 31, 1950 plus new proved reserves added in 1951		4,991,654
*Less production during 1951		267,052
Total proved reserves as of Dec. 31, 1951		4,724,602
Increase in reserves during 1951		456,939
TOTAL LIQUID HYDROCARBONS		
Total proved reserves as of Dec. 31, 1950		29 536,061
Revisions of previous estimates and extensions of old pools	+4,673,195	
New reserves discovered in 1951 in new fields and in new pools in old fields	464,750	
Proved reserves added in 1951		5,137,945
Total proved reserves as of Dec. 31, 1950 plus new proved reserves added in 1951		34,674,006
*Less production during 1951		2,481,373
Total proved reserves as of Dec. 31, 1951		32,192,633
Increase in reserves during 1951		2,656,572

* The 1951 production figures were compiled by the committee and where necessary are based on eleven months actual production with an estimate for December. Any variance between the actual production, as later reported, and the figures used herein will be compensated for through revision when the following year's reserve report is compiled. These revisions have in the past been very small.

Estimated Proved U. S. Reserves of Crude Oil, Natural Gas Liquids and Total Hydrocarbons, By States

(Sources: Crude Oil from American Petroleum Institute, natural gas liquids from API and American Gas Association)

(THOUSANDS OF BARRELS)

	Proved Reserves as of Dec 31, 1950 (1)	Changes in Proved Reserves Due to Extensions (New Crude Oil) and Revisions During 1951 (2)	[1]Proved Reserves Discovered in New Fields and in New Pools in Old Fields in 1951 (3)	Production During 1951 (4)	Proved Reserves as of Dec. 31, 1951 (Columns 1 + 2 + 3 Less Column 4) (5)	Changes in Reserves During 1951 (Column 5 Less Column 1) (6)
Crude Oil						
Alabama	5,396	3,495	.....	1,031	7,860	2,464
Arkansas	341,709	20,402	2,397	28,050	336,458	(—) 5,251
California[2]	3,733,562	374,710	7,159	354,561	3,760,870	27,308
Colorado	339.529	11,505	1,945	27,801	325,178	(—) 14,351
Illinois	564.218	140,130	3,782	61,795	646,335	82,117
Indiana	57,372	2,501	1,415	10,621	50,667	(—) 6,705
Kansas	732,187	129,105	44,748	114,094	791,946	59,759
Kentucky	55,871	12,276	665	10,263	58,549	2,678
Louisiana[2]	2,185,137	271,519	49,662	221,537	2,284,781	99,644
Michigan	78,717	(—) 2,576	2,022	14,050	64,113	(—) 14,604
Mississippi	385,705	31,121	4,103	35,542	385,387	(—) 318
Montana	111,272	3,900	2,360	9,114	108,418	(—) 2,854
Nebraska	9,700	4,731	4,250	2,763	15,918	6,218
New Mexico	591,982	63,788	9,504	53,634	611,640	19,658
New York	58,808	2,590	.....	4,247	57,061	(—) 1,747
Ohio	27,264	2,313	.....	3,141	26,436	(—) 828
Oklahoma	1,396,913	234,888	29,781	185,125	1,476,457	79,544
Pennsylvania	106,360	.....	.....	11,358	95,002	(—) 11,358
Texas[2]	13,581.642	2,532,377	192,858	991,913	15,314,964	1,733,322
Utah	21.629	3,000	6,400	1,346	29,683	8,054
West Virginia	39,042	2,000	420	2,700	38,762	(—) 280
Wyoming	841,016	180,614	20,785	68,975	973,440	132,424
Miscellaneous[3]	3,367	399	5,000	660	8,106	4,739
Total United States	25,268,398	4,024,698	389,256	2,214,321	27,468,031	2,199,63
Natural Gas Liquids[4]						
Alabama[5]	.....	.....	.....	.....	.....	.....
Arkansas	52,938	(—) 110	80	1,858	51,050	(—) 1,888
California[2]	363,387	(—) 4,596	.....	29,475	329,316	(—) 34,071
Colorado	12,921	(—) 521	.....	490	11,910	(—) 1,011
Illinois	26,259	2,006	28	3,721	24,572	(—) 1,687
Indiana	152	13	17	33	149	(—) 3
Kansas	163,578	(—) 14	330	4,325	159,569	(—) 4,009
Kentucky	11,927	369	185	2,003	10,478	(—) 1,449
Louisiana[2]	643,512	64,775	9,294	32,808	684,773	41,261
Michigan	1,018	89	1	99	1,009	(—) 9
Mississippi	55,897	47	995	4,649	52,290	(—) 3,607
Montana	3,547	79	.....	285	3,341	(—) 206
Nebraska	235	1,808	666	123	2,586	2,351
New Mexico	93,897	44,221	661	8,160	130,619	36,722
Ohio	1,688	94	11	83	1,710	22
Oklahoma	279,903	52,715	4,319	25,812	311,125	31,222
Pennsylvania	2,599	119	59	214	2,563	(—) 36
Texas[2]	2,496,039	470,160	55,702	144,560	2,877,341	381,302
Utah	194	(—) 128	.....	5	61	(—) 133
West Virginia	8,976	20,845	282	6,182	23,921	14,945
Wyoming	48,987	(—) 3,478	2,543	2,166	45,886	(—) 3,101
Miscellaneous[6]	9	4	321	1	333	324
Total United States	4,267,663	648,497	75,494	267,052	4,724,602	456,939
Total Liquid Hydrocarbons[7]						
Alabama[8]	5,396	3,495	.....	1,031	7,860	2,464
Arkansas	394,647	20,292	2,477	29,908	387,508	(—) 7,139
California[2]	4,096,949	370,114	7,159	384,036	4,090,186	(—) 6,763
Colorado	352,450	10,984	1,945	28,291	337,088	(—) 15,362
Illinois	590,477	142,136	3,810	65,516	670,907	80,430
Indiana	57,524	2,514	1,432	10,654	50,816	(—) 6,708
Kansas	895,765	129,091	45,078	118,419	951,515	55,750
Kentucky	67,798	12,645	850	12,266	69,027	1,229
Louisiana[2]	2,828,649	336,294	58,956	254,345	2,969,554	140,905
Michigan	79,735	(—) 2,487	2,023	14,149	65,122	(—) 14,613
Mississippi	441,602	31,168	5,098	40,191	437,677	(—) 3,925
Montana	114,819	3,979	2,360	9,399	111,759	(—) 3,060
Nebraska	9,935	6,539	4,916	2,886	18,504	8,569
New Mexico	685,879	108,009	10,165	61,794	742,259	56,380
New York (a)	58,808	2,500	.....	4,247	57,061	(—) 1,747
Ohio	28,952	2,407	11	3,224	28,146	(—) 806
Oklahoma	1,676,816	287,603	34,100	210,937	1,787,582	110,766
Pennsylvania	108,959	119	59	11,572	97,565	(—) 11,394
Texas[2]	16,077,681	3,002,537	248,560	1,136,473	18,192,305	2,114,624
Utah	21,823	2,872	6,400	1,351	29,744	7,921
West Virginia	48,018	22,845	702	8,892	62,683	14,665
Wyoming	890,003	177,136	23,328	71,141	1,019,326	129,323
Miscellaneous[9]	3,376	403	5,321	661	8,439	5,063
Total United States	29,536,061	4,673,195	464,750	2,481,373	32,192,633	2,656,572

[1] Only a limited area is assigned to each new discovery, even though the committee may believe that eventually a much larger area will produce; for, in the report, the concern is only with actually proved reserves.

[2] Includes off-shore reserves.

[3] Under Miscellaneous are included crude oil data for Florida, Missouri, North Dakota, Tennessee and Virginia.

[4] Natural gas liquids include condensate, natural gasoline, and liquefied petroleum gases.

[5] Included below in Miscellaneous.

[6] Under Miscellaneous are included natural gas liquids for Alabama, Florida, and North Dakota.

[7] Total liquid hydrocarbons includes crude oil and natural gas liquids (condensate, natural gas liquids, and liquefied petroleum gases.)

[8] Crude oil only.

[9] Includes Alabama natural gas liquids; Missouri, Tennessee, and Virginia crude; and Florida and North Dakota crude and natural gas liquids.

barrels actually estimated. This indicated that there was a deficiency in reserve-proving in 1951 amounting to 1,614,118,000 barrels. This deficiency occurred in spite of the fact that 5,137,945,000 barrels were reported as having been proved up in 1951. Avoidance of this deficiency would have required the proving up of 6,752,063,000 barrels of new liquid hydrocarbon reserves, or 2.72 barrels of reserves per barrel of production.

This high ratio of needed oil finding to production is explained by the sharp rise in production in 1951, which called for the setting up of large extra reserves to support the important new component of production. In effect, it was essential in 1951 to prove up 2.5 billion barrels of reserves in direct compensation for that amount produced; and in addition, to prove up 4.2 billion barrels to set up as a reserve 13.6 times greater than the 310 million barrels of additional production in 1951 which did not occur in 1950 and back of which no reserves had been established.

U. S. reserves of crude only at end of 1951, estimated at 27,468,031,000 barrels, equaled only 12.4 barrels for each of the 2,214,321,000 barrels produced in 1951. Smaller crude reserves of 25,268,398,000 barrels at the end of 1950 had been equivalent to 13.0 barrels for every barrel produced in 1950. If crude reserves had been kept 13.0 times as great as the growing annual production, they would have totaled 28,786,173,000 barrels at the end of 1951, or 1,318,142,000 barrels

Estimated Proved Recoverable Reserves of Natural Gas Liquids in the United States, By States

(Includes Condensate, Natural Gasoline, and Liquefied Petroleum Gas)
Sources: American Gas Association and American Petroleum Institute
(Thousands of Barrels of 42 U. S. Gallons)

	Reserves as of Dec. 31, 1950	CHANGES IN RESERVES DURING 1951			RESERVES AS OF DECEMBER 31, 1951			
		Extensions and Revisions	Discoveries of New Fields and New Pools in Old Fields	Net Production	Total (Columns 6 + 7 + 8, also Columns 1 + 2 + 3 Less Column 4)	Non-Associated	Associated	Dissolved
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Arkansas	52,938	(—) 110	80	1,858	51,050	30,326	7,167	13,557
*California	363,387	(—) 4,596	0	29,475	329,316	0	112,854	216,462
Colorado	12,921	(—) 521	0	490	11,910	301	0	11,609
Illinois	26,259	2,006	28	3,721	24,572	22	50	24,500
Indiana	152	13	17	33	149	18	22	109
Kansas	163,578	(—) 14	330	4,325	159,569	155,367	1,430	2,772
Kentucky	11,927	369	185	2,003	10,478	10,478†	0	0
*Louisiana	643,512	64,775	9,294	32,808	684,773	540,276	99,303	45,194
Michigan	1,018	89	1	99	1,009	595	0	414
Mississippi	55,897	47	995	4,649	52,290	25,750	20,912	5,628
Montana	3,547	79	0	285	3,341	3,341	0	0
Nebraska	235	1,808	666	123	2,586	2,314	169	103
New Mexico	93,897	44,221	661	8,160	130,619	47,842	32,580	50,197
Ohio	1,688	94	11	83	1,710	1,710†	0	0
Oklahoma	279,903	52,715	4,319	25,812	311,125	120,293	27,993	162,839
Pennsylvania	2,599	119	59	214	2,563	2,563†	0	0
*Texas	2,496,039	470,160	55,702	144,560	2,877,341	1,398,327	391,917	1,087,097
Utah	194	(—) 128	0	5	61	61	0	0
West Virginia	8,976	20,845	282	6,182	23,921	23,921†	0	0
Wyoming	48,987	(—) 3,478	2,543	2,166	45,886	40,623	5,263	0
‡Miscellaneous	9	4	321	1	333	0	0	333
Total	4,267,663	648,497	75,494	267,052	4,724,602	2,404,128	699,660	1,620,814

* Includes off-shore reserves. † Not allocated by types but occurring principally in the column shown.
‡ Miscellaneous includes, Alabama, Florida, and North Dakota.

Summary of Changes in 1951 in Proved U. S. Reserves of Natural Gas.

Source: American Gas Association
(Millions of Cubic Feet)

Total proved reserves as of Dec. 31, 1950	185,592,699
Extensions and revisions of previous est.	13,013,606
New reserves discovered in 1951	3,039,385
Net changes in "stored gas" during 1951	132,751
Total proved reserves added and net changes in "stored gas" during 1951	16,185,742
Total proved reserves as of Dec. 31, 1950 and additions during 1951	201,778,441
Deduct production during 1951	7,966,941
Total proved reserves of natural gas as of Dec. 31, 1951	193,811,500
Increase in natural gas reserves during 1951	8,218,801

Estimated Proved Recoverable Reserves of Natural Gas in the United States, By States

Source: American Gas Association
(Millions of Cubic Feet—14.65 psia, at 60 deg. F)

	Reserves[b] as of Dec. 31, 1950	CHANGES IN RESERVES DURING 1951				RESERVES AS OF DECEMBER 31, 1951[b]				
		Extensions and Revisions[b]	Discoveries of New Fields and New Pools in Old Fields[b]	Net Change in Underground Storage[c]	Net Production[d]	Total (Columns 7 + 8 + 9 + 10, Also Columns 1 + 2 + 3 + 4 Less Column 5)	Non-Associated[e]	Associated[f]	Dissolved[g]	Underground Storage[h]
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Arkansas	907,593	27,545	38,965	(—) 4	42,785	931,314	478,298	149,733	301,287	1,996
California[i]	9,760,386	170,711	66,827	(—) 4,317	511,162	9,482,445	2,615,335	2,155,881	4,696,387	14,842
Colorado	1,115 473	22,955	24,504	0	24,481	1,138,451	487,134	42,142	609,175	0
Illinois	229,893	29,795	5,650	0	38,205	227,133	4,333	10,000	212,800	0
Indiana	31,190	2,520	3,340	297	6,540	30,807	3,500	4,500	21,760	1,047
Kansas	13,790,834	76,206	40,971	2,326	452,839	13,457,498	13,015,271	133,419	277,181	31,627
Kentucky	1,330,583	59,386	9,520	(—) 401	73,500	1,325,588	1,253,003	0	61,400	11,185
Louisiana[i]	28,533,266	1,147,998	480,933	0	1,157,166	29,005,031	23,147,675	3,829,371	2,027,985	0
Michigan	195,074	8,786	230	10,347	11,412	203,025	119,011	0	41,366	42,648
Mississippi	2,519,206	86,321	35,477	40	201,075	2,439,969	1,721,717	405,552	312,660	40
Montana	797,361	69,336	0	3,069	41,659	828,107	700,358	39,469	80,717	7,563
Nebraska	44,106	30,947	26,646	0	5,889	95,810	67,351	7,906	20,553	0
New Mexico	6,990,670	4,785,791	132,187	(—) 2,834	315,835	11,589,979	8,273,960	2,351,741	949,026	15,252
New York	64,779	100	0	4,814	2,900	66,793	50,642	0	528	15,623
Ohio	558,862	32,527	8,450	30,696	41,400	689,135	551,825	0	32,800	104,510
Oklahoma	11,634,287	769,182	117,604	10,380	727,116	11,804,337	7,368,214	1,007,720	3,393,654	34,749
Pennsylvania	627,171	38,272	33,000	43,012	122,000	619,455	480,191	0	38,400	100,864
Texas[i]	102,404,077	5,311,803	1,854,153	1,330	3,918,134	105,653,229	70,322,632	18,228,896	17,099,881	1,820
Utah	84,752	8,784	6,154	0	3,845	95,845	78,720	0	17,125	0
West Virginia	1,650,675	147,107	21,900	33,817	182,000	1,671,499	1,504,366	0	77,150	89,983
Wyoming	2,194,989	161,115	66,518	179	82,503	2,340,298	1,479,958	354,385	505,263	692
Miscellaneous[a]	27,472	26,419	66,356	0	4,495	115,752	47,913	0	67,839	0
Total	185,592,699	13,013,606	3,039,385	132,751	7,966,941	193,811,500	133,771,407	28,720,715	30,844,937	474,441

[a] Includes Alabama, Florida, Maryland, Missouri, North Dakota and Virginia. [b] Excludes gas loss due to natural gas liquids recovery. [c] The net difference between gas stored in and gas withdrawn from underground storage reservoirs, inclusive of adjustments. [d] Net production equals gross withdrawals less gas injected into producing reservoirs; changes in underground storage are excluded. December production estimated occasionally. [e] Non-associated gas is free gas not in contact with crude oil in the reservoirs. [f] Associated gas is free gas in contact with crude oil in the reservoirs. [g] Dissolved gas is gas in solution with crude oil in the reservoirs. [h] Gas held in underground reservoirs for storage purposes only. [i] Includes off-shore reserves.

BETHLEHEM AT BEAUMONT Serves the Oil and Gas Industry

The photograph above shows only a section of Bethlehem's Beaumont Yard, but it indicates graphically why this combination shipbuilding and ship-repairing unit is regarded as one of the most progressive in the nation.

Here, in this view, are six different types of craft. Three of these types, the drill barge, gas compressor barge and tank battery barge, were developed by the Beaumont Yard to make possible more efficient exploitation of off-shore oil and gas fields. The three Beaumont-built oil barges were designed to provide economical transportation of petroleum and its products. The Liberty ship and naval craft in the background are undergoing repairs. Not shown are the yard's excellent facilities, including a 15,000-ton dry dock, for repairing tankers and other commercial and naval vessels.

Yes, this photograph tells a story . . . the story of how Bethlehem's Beaumont Yard serves the oil and gas industry.

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Baltimore Harbor	Beaumont, Texas
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SHIPBUILDING YARDS

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Sparrows Point, Md.	Beaumont, Texas
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more than they did; and reserve proving in 1951 necessarily would have been greater by the latter amount than the 4,413,954,000 barrels actually proved up, thus totaling 5,732,096,000 barrels, equivalent to 2.59 barrels for each barrel produced.

Similarly, reserves of 4,724,602,000 barrels of natural gas liquids at end of 1951 equaled only 17.7 barrels for each barrel produced, whereas the 4,267,663,000 barrels at end of 1950 were 18.8 times larger than annual production. If end of 1951 reserves had been 18.8 times 1951's production, they would have totaled 5,020,578,000 barrels, or 295,976,000 more than they did; and reserve proving would have had to cover that deficiency in addition to the 723,991,000 barrels actually proved, thus totaling 1,019,967,000 barrels, equivalent to 3.82 barrels of reserves proving per barrel of production.

The above mentioned deficiencies in oil finding are indicated even on the current basis of the U. S. as a relatively large net importer of petroleum, obtaining a substantial part of requirements from foreign sources. The U. S. was a net importer of 153,293,000 barrels (420,000 daily) in 1951, as crude and product imports totaled 307,721,000 barrels, while exports totaled 154,428,000. If this 153,293,000 barrels of demand had been met by domestic production instead of net imports, and this production had been backed up by crude reserves 13.0 times as great as annual production, such additional reserves available in the U. S. would have amounted to approximately 2 billion barrels. Development of such reserves of 2 billion barrels in avoidance of net imports, which did not prevail before World War II, can be said to have been called for over the past five years, rather than wholly in 1951; as the U. S. first became a net importer in 1947 and subsequenty has steadily increased net imports, except in 1951, when abnormal exports held down the excess of imports over exports.

Reserves of natural gas at the end of 1951, estimated at 193,811,500 million cubic feet, were only 24.3 times greater than annual production at the 1951 record rate of 7,966,941 million cubic feet. The gas reserves of 185,592,699 million feet at end of 1950 had been 26.9 times annual production in 1950. The 16,052,991 million cubic feet of new reserves proved up in 1951 were twice the year's production and provided a net increase of 8,218,801 million feet. This addition might be considered satisfactory, for in spite of the decline of the ratio of reserves to production to the basis of reserves 24.3 times as great as annual production, that ratio still remained relatively high—almost twice as high as that for crude oil. However, natural gas production has been increasing spectacularly, with the result that proved reserves now do not represent very much more than the 20 years' supply that must be shown as reserves available to an individual proposed interstate pipe line in order to secure Federal Power Commission authorization for its construction.

Deficiencies in Reserve Proving in 1951, on Basis of Failure to Maintain Unchanged Ratio of Reserves to Production.

Computed by WORLD OIL from data of American Petroleum Institute and American Gas Association.

(THOUSANDS OF BARRELS)

ITEM	Crude Oil	Natural Gas Liquids	Total Liquid Hydrocarbons
1. Production in 1950	1,943,776	227,411	2,171,187
2. Reserves, end of 1950	25,268,398	4,267,663	29,536,061
3. Ratio of reserves to production, end of 1950 (Item 2 divided by Item 1)	13.0	18.8	13.6
4. Production in 1951	2,214,321	267,052	2,481,373
5. Reserves needed, end of 1951, if ratio of reserves to production had been kept same as at end of 1950 (Item 4 times Item 3)	28,786,173	5,020,578	33,806,751
6. Actual reserves estimated for end of 1951	27,468,031	4,724,602	32,192,633
7. Actual ratio of reserves to production end of 1951 (Item 6 divided by Item 4)	12.4	17.7	13.0
8. Deficiency in reserves proving in 1951 (Item 5 less Item 6)	1,318,142	295,976	1,614,118
9. Reserves actually proved in 1951	4,413,954	723,991	5,137,945
10. Reserves proving needed in 1951 if reserves to production ratio had been kept same for end of 1951 as at end of 1950 (Item 8 plus Item 9)	5,732,096	1,019,967	6,752,063
11. Ratio of barrels reserves proving needed in 1951 per barrel of production (Item 10 divided by Item 4)	2.59	3.82	2.72

New Lines to Ease Problem

• CONTINUED FROM PAGE 55

otherwise might be faced with drastically prorated and curtailed quotas. Expected to benefit also are Scurry and new fields being opened in Western New Mexico, especially South Saunders and Denton.

It is generally expected that movement of West Texas crude through the new lines will alleviate, in particular, the acute shortage in oil of 36 gravity and less along the Gulf Coast; the need for additional burning oils; and the Great Lakes and Atlantic seaboard supply.

During the Iranian crisis, more West Texas crude was needed, but it could not be moved. Consequently, these lines will have an added safety factor should another emergency occur. West Texas Gulf's 26-inch section of line will be the largest, though not the longest, crude line in North America, an accomplishment of no small import in the face of continued unrest of the political front. West Texas Gulf has let these contracts for the 274 miles of 26-inch line: From Colorado City east for 60 miles, Anderson Bros., Corporation of Houston; 120 miles from west of Abilene to Granbury, Associated Pipe Line Contractors, Inc., Houston; and 94 miles between Wortham and Granbury, Anderson Bros.

Companies participating in the West Texas Gulf and Rancho lines are taking advantage of the multiple benefits resulting from the operation of larger diameter lines rather than smaller ones, which may be summed up to transporting oil more cheaply. Participating in West Texas Gulf are Gulf Oil Corporation, which will construct and operate the line, The Pure Oil Company, Cities Service Company, Sun Oil Company, and Standard Oil Company of Ohio; participating in the Rancho line are Shell Pipe Line Company, which will design, construct and operate the system, Sinclair Pipe Line Company, Pan American Pipe Line Company, Phillips Pipe Line Company, Nantucket Pipe Line Company (a wholly-owned subsidiary of Eastern States Petroleum Company, Inc.), Crown Central Petroleum Corporation, and Ashland Oil and Refining Company.

While standing the present in good stead, it is also to the future that the participating companies are looking in their ventures—a future certain to bring a more dominant role to West Texas crude, reserves of which exist in such quantities as to point to the area as the focal supply point which will make up for fields whose producing days are numbered.

Price Freeze Endangers Industry Expansion

By JAMES V. BROWN

Petroleum Economics Analyst
Chairman, Cost Study Committee, IPAA

THE Petroleum Administration for Defense says 80,000 new oil and gas wells are needed in the U. S. in the 18-month period beginning July 1. The goal for 1953 is 55,000 new wells. To meet this program the average price of crude—now frozen at $2.56 per barrel—must rise to at least $3.25 per barrel. Further price adjustments will be necessary to meet any increases in replacement and production costs. Unless crude prices are decontrolled, or an adequate ceiling set promptly, the oil industry cannot reach the goal. In the past, crude price increases always have stimulated exploration and discovery. Thereby resulting in lower product prices to the consumer.

Crude petroleum replacement costs —the current cost of finding, developing and producing crude oil— is important not only to the petroleum industry but to the entire economy. A barrel of oil consumed must be replaced by approximately two barrels of newly discovered and developed oil if the industry is to continue to supply defense requirements and civilian consumers with the essential products derived from crude petroleum.

Through the Defense Production Act and its amendments, Congress intended to encourage expansion of productive capacity and supply to meet military and civilian requirements. A continuation of the present federal price freeze on crude can and will defeat the intention of Congress.

Unlike most other large industries, the major normal operation of the petroleum industry is replacement of capital assets through the discovery and development of new supplies in the form of proved reserves. The importance of this difference between petroleum and other commodities can hardly be over-emphasized. The real inventory in the crude petroleum industry is the proved reserves. The cost of this replacement process is basic to the economic health of the entire industry. As new reserves become increasingly hard and, therefore, more costly to find, the industry faces the problem of selling an asset that cannot be replaced at its original cost, but that must be replaced if the industry is to continue to meet the nation's oil requirements.

IT IS ESSENTIAL to the national security and welfare that crude prices be decontrolled or that adequate ceilings be established promptly. Continuation of the present federal price freeze on crude petroleum can and will defeat the intention of Congress to encourage expansion of productive capacity and supply to meet military and civilian requirements for national security.

Replacement operations play a large role in the industry's activity. Normally more than 60 percent of funds from the sale of crude are spent for further exploration and development.

Obviously, crude prices must be adequate to provide for exploratory and development operations, thereby preventing impairment of, and preferably to increase, both proved reserves and productive capacity.

Price control authorities who refuse or neglect to establish a fair crude oil price ceiling tend to create a crude oil shortage. This causes crude to sell at scarcity prices. While there are many factors affecting the determination of crude oil prices in a free economy, the action of crude oil purchasers in doubling oil prices within eighteen months after the termination of the Office of Price Administration conformed very closely to the price action that would have been taken on the basis of increased replacement costs. This furnished substantial evidence that crude oil replacement costs are recognized by the industry—whether deliberately or otherwise—as an important factor in the determination of prices. To this extent such recognition of replacement costs in price determination may be regarded as an established practice in the industry.

Heretofore all government surveys on the cost of producing crude have been based on historic or bookkeeping costs. Frozen prices on a basis of unrealistic bookkeeping data will penalize both the petroleum industry and consumers through the shortages that are bound to follow. Price is an important function of supply and demand. Economic concepts must be the regulating factor rather than bookkeeping records on costs and profit.

Productive Capacity

Reserve productive capacity must be greatly expanded to meet defense needs. When demand for petroleum in the U. S. was less than 4 million barrels per day, a reserve productive capacity of more than 1 million barrels per day was available. In the peak war year of 1945—the fourth year of price control—production substantially exceeded capacity. Seventy thousand wells had not been drilled for lack of funds, material and manpower. Postwar activity raised the excess capacity level to about 835,000 barrels per day over production in January, 1951. However, the production level then was nearly 6½ million barrels daily. Production requirements in 1952 may reach 7 million barrels daily. The anticipated increase in petroleum demand and an adequate excess reserve capacity can be met provided the usual economic incentives are continued and the necessary funds, material and manpower are available.

Total demand for petroleum, including exports, has more than doubled in the last 15 years. This is an average annual increase of approximately 6 percent. The average annual

increase during the past two years was more than 10 percent. Prewar, less than 5 percent of the total demand was met by imports. In the last two years imports supplied approximately 12 percent. PAD, in urging the achievement of a larger margin of capacity, has pointed out that "A full-scale war, or continued political difficulties in the Middle East, might result indirectly in a sharp reduction of our imports, now furnishing about an eighth of our supply."

It is estimated that demand for petroleum will exceed 8.5 million barrels daily in 1955.

Drilling Activity

Normally, the price of oil controls the rate of drilling. Under government regulations, however, net margin after deduction of replacement costs is the controlling factor. Prewar, an average of 70 feet of hole was drilled for every 1000 barrels of petroleum produced. During the five war years, the average fell to 48 feet. Postwar, under the stimulus of a free market, drilling activity rose to 74 feet in 1950. The average has declined, however, in the first year of defense regulations to 71 feet of hole drilled per 1000 barrels of oil produced.

Total footage drilled in 1951 was 174 million feet. It will require nearly 215 million feet to meet the 55,000-well goal in 1953.

The API recently announced with justifiable pride "spectacular gains in the nation's proved reserves of liquid petroleum and natural gas" in 1951. Proved reserves "reached new all-time peaks." The net increase is the "greatest one-year addition in history." The report says that: "This is the first time the oil industry ever topped the 5-billion barrel mark for new oil supplies in any one year."

These accomplishments, spectacular as they may be, were attained only at the cost of several other new highs. An all-time high in exploratory and development activity and an all-time high in costs of labor, materials and taxes.

An article in *Business Week* (March 8, 1952) is headed, "Oil Sitting Pretty —For Now." The two little words "For Now" are highly significant. After pointing out some of the industry's accomplishments and alleged advantages it concludes: "But there is at least one trouble the oil industry is going to run into some day. Right now most U. S. oil is produced from older wells. Most newer oil finds cost more to develop. So costs of producing oil are rising. This means that the squeeze on the oil industry is bound to get tighter."

In the five postwar years the new oil added through discoveries, extensions and revisions of previous estimates was equal to an average of 26 barrels for each foot of hole drilled in that period. In the five prewar years the comparable figure was 28 barrels. It must be remembered that footage in this calculation is merely a unit of measurement of trend in the cost of finding oil. Dry hole footage does not produce any oil, however, dry holes may have some influence in estimating the potentialities in the area.

Discoveries of New Oil

The results of drilling activities measured by oil reserves added in the five years preceding World War II and the five postwar years indicate that another new high has been reached in required effort and cost to discover new oil reserves. Discoveries in 1951 compared to footage drilled indicate a result less than 10 prcent of the discoveries in 1937. Postwar results are less than one-third of the prewar discoveries-per-foot of exploratory drilling.

This is not intended as a tale of running out of oil, but to point out the need to exert greater effort at considerably greater cost to maintain oil reserves. Indicated production requirements by 1955 mean still higher "new highs" in new oil to be found.

Assuming that the basic standards of estimating new oil reserves by the API has not changed since 1937 and that classification of exploratory wells and footage reported by WORLD OIL remained constant in the same period, it appears from Table 1, that it took more than ten times as much effort in 1951 to discover the same relative amount of new oil discovered in 1937. However, discoveries of new oil are not solely related to the footage drilled in the same year. Much of the footage drilled finds no oil Exploratory effort is spread over a number of years. Using the footage drilled as a yardstick over the five prewar years as compared with the five postwar years, results in the latter period averaged only 32 percent of prewar. When the increases in costs of exploratory services and materials are added—which doubled in the latter period—the cumulative cost of increased units of activities and increased unit costs indicate that the average replacement cost of finding a barrel of new oil postwar was approximately six times that of prewar.

Subsequent revisions and extensions will substantially add to first estimates of recoverable oil. However, there is no escape from the fact that the trend—as measured by new reserves found in relation to exploratory footage—indicates conclusively that the cost of finding oil has increased sharply

The National Petroleum Council in its report on "Petroleum Productive Capacity" points out that the outlook for petroleum supplies in the long term view is favorable. The committee's "view" however, is based on a continuation of economic incentives, maintenance of conservation practices, adequate supplies of materials and manpower, and no changes in federal tax provisions and regulations with respect to petroleum production.

Dry Hole Footage

Total dry hole footage in 1937 was 20.9 million feet. In 1951 dry hole footage totaled 63.1 million feet. The extent of dry hole activity as measured by units of footage drilled in 1951 was up over three times com-

TABLE 1

Exploratory Drilling as Related to Estimated Petroleum Reserves Discovered (Initial Estimates)

YEAR	Exploratory Wells		New Reserves Discovered (Initial Estimate)	
	Number of New Wells[1]	Total Footage Drilled[1]	Total (Thousand Barrels)[2]	Average per Foot Drilled (Barrels)[3]
1937	3222	8,801,201	950,896	108.04
1938	2612	9,012,457	830,101	92.11
1939	2961	9,774,484	355,739	36.39
1940	3165	10,712,651	294,374	27.47
1941	3697	12,450,478	432,848	34.77
Prewar Average	3131	10,150,254	572,792	56.43
1947	5874	24,190,449	504,731	20.86
1948	7197	30,325,767	461,164	15.21
1949	7721	31,125,418	982,982	31.58
1950	8997	36,241,911	623,099	17.19
1951	10,793	46,362,332	464,750	10.02
Postwar Average	8116	33,649,175	607,345	18.05
Index of postwar average in relation to prewar average	259.21	331.51	106.03	31.98

[1] WORLD OIL.

[2] 1937-1941 based on estimates of A.P.I. for crude oil there has been added estimates for reserves of natural gas liquids to approximate for those years, data reasonably comparable to the A.P.I. reported data for the years 1947 to 1951 inclusive for "Total Liquid Hydrocarbons" with which, data in this table for 1947-1951, are in agreement.

[3] Calculated.

right to 35
left twice to 17
right to 4
left to 21

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pared to 1937. Added to the rise in units of effort is the cost of drilling and other services connected with dry hole losses, which in 1951 were about 2⅓ times the cost of such services in 1937, making a cumulative rise in the over-all cost of dry holes of nearly seven times the cost in 1937. The cost rose quite sharply in each of the postwar years. It is estimated that dry hole losses averaged about 12 to 13 cents per barrel of company interest oil produced prewar. The comparable average in 1947 is estimated at 22 cents rising to 36 cents in 1950 and 43 cents in 1951.

While the treatment of intangible drilling costs for tax purposes is optional—whether to capitalize and recover costs through amortization or expense the entire amount against each year's operations—the practice of expensing such intangibles each year is more generally used. The cost of drilling has risen as a result of the increase in number of wells and footage drilled. Deeper drilling not only increases costs for the additional footage but at an increasingly higher rate, as wells go deeper. Contract rates for drilling do not in themselves reflect the total cost of drilling under contract. Extras are a substantial factor in total costs These extras have increased substantially as have all other materials and services.

Total footage drilled of productive and service wells averaged 72.9 million feet in the five prewar years as compared with an annual average of 97.4 million feet in the five postwar years, up 33.6 percent. Allowing for increased per foot costs for services and associated activities, cumulative costs more than doubled in the postwar period over the prewar period.

Depletion and Depreciation

Traditional accounting methods for computing depletion and depreciation on cost do not reflect currently higher replacement costs of acquiring and equipping oil properties

The accumulated reserves created each year through accounting charges for depletion and depreciation are woefully inadequate to do the job of providing the funds for replacing oil reserves currently consumed and equipment which has worn out.

For years there has been a lack of understanding of the problem of the economic concept of replacement costs as compared with bookkeeping practices. Book costs are often cited to prove the profitability of crude producing operations while actual or current costs are ignored. The accounting concept of depletion and depreciation as recorded in book costs is simply the writing off of fixed assets over the life of the property. The economic concept is that the return of capital through depletion and depreciation will permit the replacement of assets used up or worn out. These concepts are in agreement only when the cost of a particular asset does not change during the life of the asset. In an inflationary economy such as that existing today, assets cannot be replaced at their returned cost. The economic concept cannot be satisfied by the accounting concept. This failure is applicable to all industry and even more apparent in any industry operating a wasting asset.

More than 75 percent of the crude produced and sold in 1951 came from oil fields discovered prior to 1942, indicating that total profits currently reported are calculated on the basis of historical finding costs on 75 percent of the oil sold which costs are only a fraction of the current replacement costs.

The industry's bookkeeping profits reflect this large percentage of low-cost reserves. But current operations must be planned in the light of present costs of replacement The sharp increases in current replacement costs will not be adequately reflected in the bookkeeping figures and in the financial statements for some years. It is apparent, therefore, that the use of present accounting methods does not and cannot be expected to disclose the real economic gain or loss in the petroleum industry. The profits being shown by the financial reports of the oil-producing companies today are unrealistic and misleading from the standpoint of real economic gain or loss.

During the period of more than four years while the level of crude prices has remained unchanged, the cost of producing crude in the U. S., even on a bookkeeping basis, has increased substantially.

Practically all important and significant factors entering into the cost of producing oil have risen sharply, such as total footage completed, dry holes drilled and average depth of wells drilled. To these important and substantial factors of increased costs must be added the increased costs of wages and salaries, equipment, supplies, services and many others.

It is estimated that composite costs have increased between 45 and 50 percent during the period of unchanged crude prices.

This is offset in part by the rise in production. However, the net additional cost per barrel of company interest oil in 1951 is estimated to be between 35 and 50 cents per barrel.

The outlook on the basis of present frozen prices for crude, assuming all cost and price factors could possibly remain at present levels, is shown in Table 2.

The longer the price lid remains on crude petroleum the higher the price must eventually go if productive capacity should fail to meet defense requirements through lack of sufficient margin to permit adequate exploration and development.

Margin, as used in this study and in previous governmental studies on the cost of producing crude oil, is arrived at before deducting interest, bad debts, contributions, losses—other than dry hole losses, income and excess profits taxes, dividends, reserves for contingencies, excess of capital expenditures over capital extinguishments and other items which could not be classified as operating expense or general and administrative expense.

The margin above costs, according to a study made by the Petroleum Industry War Council, should be sufficient to provide for:

- Funds for the exploration needed to find adequate new reserves.
- Funds to cover replacement costs.
- A reserve fund for secondary recovery or other conservation measures.
- A fair return on borrowed and invested capital, taking into consideration the extreme hazards involved in searching for and finding oil.
- To maintain the industry as a healthy, going concern.
- For federal and state income taxes.

TABLE 2

YEAR	REVENUE FROM OIL		Total Expenditures	MARGIN		Indicated Average Price Needed to Maintain 1948-9 Margin Per Barrel
	Net Production	Sales at $2.56 per Barrel	Exploration Developing Operating	Sales Over Expenditures	Per Barrel of Net Production	
	Billion Barrels	Billion Dollars	Billion Dollars	Billion Dollars		
1948-49	1.8	$ 4.6	$ 3.5	$ 1.1	$0.64	$ 2.56
1951	2.1	5.4	4.8	0.6	.29	2.91
1952	2.2	5.6	5.1	0.5	.23	2.97
1953	2.3	5.9	5.8	0.1	.04	3.16
1954	2.4	6.1	6.0	0.1	.02	3.18
1955	2.5	6.4	6.4	0.0	.00	3.20

Oil Sufficiency Requires
Free, Profitable Industry

By GUY H. WOODWARD
Attorney, Noble Drilling Corporation, Tulsa

THE long-term availability of petroleum supplies in this country is not threatened because of any inability to find oil in the earth or even to produce it from oil shales, coal, tar sands and other synthetic sources, and to transport it, refine it and distribute it to the consumers. The threat lies in the loss of those individual freedoms that make it possible to expand these industrial operations as required. If the oil industry is given a political climate which permits a free competitive system of enterprise and a government philosophy that recognizes the economic right to make and retain a reasonable profit in proportion to the efforts exerted, then it will make available ample petroleum supplies to meet the growing needs of a continued higher standard of living for many years to come.

A recent report of a committee of the National Petroleum Council emphasized that the current level of production of oil and gas in the U. S. has not been the result of chance or fortuitous discoveries of unlimited reserves, coupled simply with the application of money, manpower and materials. Instead, the supply has been almost totally dependent upon the development and adaptation of scientific and technical improvements in discovery methods, in the development of subsurface pools, and in the techniques of recovery, tranportation and processing. No amount of planning, manpower or management ability, or the expenditure of money, could bring oil from 12,000 to 15,000 feet within the earth without the technical developments that have made it physically possible to drill to such depths, to control the pressures encountered, and to regulate the flow of oil and gas.

It therefore follows that the long-term future availability of oil and gas in this country may not be stated in terms of specific and concrete quantities which may be discovered and become recoverable by existing techniques; but instead, the future must be evaluated in terms of future technological progress. Certainly, it is beyond the limitations of anyone to conceive the thousands of unborn ideas yet to come to the minds of men, or the future scientific discoveries yet to be unfolded by research and experimentation. The history of our scientific advancement is such, however, that it inspires us with confidence that, given the proper incentive and permitted the individual freedom to think, to act, and to use our resources, both money and materials, we will continue to make available the petroleum requirements of this nation for a future period upon which we cannot now place a time limitation.

ADEQUATE U. S. OIL SUPPLY in the future is assured by the scientist's ability to find it or even to make it synthetically. But sufficiency of supply is threatened by increased economic and political restrictions on individual and corporate freedom and initiative. Ample supplies will be provided if America's traditionally free, competitive economic system, driven by profit incentive, is saved and not bled white by unreasonable taxes imposed by wasteful government.

Petroleum engineers estimate that we have 100 billion barrels of known reserves of oil and natural liquids, yet only about 32 billion barrels are recoverable under present production methods. This means about 70 billion barrels of oil and natural liquids already discovered are awaiting the development of scientific techniques that will bring it to the surface. In the last 50 years the industry has increased its recovery from about 20 percent to as much as 80 percent, or even higher in some cases. What reason is there not to expect continued progress in this field?

In 1941 the American Association of Petroleum Geologists published a symposium on the future oil provinces of the U. S. and Canada. In 1951 it published a similar symposium. Each of these surveys represents a composite of the most responsible geological opinion of the day. During the decade covered by these studies, 18 billion barrels of oil and 61 trillion cubic feet of gas were produced. Yet, during the same period we added to our known recoverable reserves 10 billion barrels of oil and 100 trillion cubic feet of gas, having fuel value of about 27 billion barrels of oil. The 1951 report describes approximately 650,000 square miles of prospective oil territory not included in the 1941 report.

Notwithstanding this huge known reserve, the supply of petroleum in the U. S. would become critically deficient within a short time if it were to remain dependent on the proved reserves discovered by past operations. The supply is perpetuated only through continuous exploration devoted to the finding of new oil and gas pools. The proved reserves constitute only the working stock from which our current withdrawals are made rather than the primary base of long-term supply. The important base for long-term supply is necessarily the continued discoveries brought about through continued exploration. Exploration once consisted in the drilling of wells on or near oil or gas seeps, or simply on hunches. Today, exploration is a highly organized and intensive activity, based on the science of geology and implemented by such scientific aids as the seismograph, the gravity meter, the magnetometer, and other devices. The recovery of oil has become a highly technical process requiring a wealth of specialized information regarding

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Tested on 300 Wells

The first working models of the Multi-Knife Casing Mill, as it was called, were initially tested September, 1939, in the Louden Pool area at St. Elmo, Illinois. Using six drilling rigs, sections of pipe were removed from 300 wells. From one to three sections were milled out of each well, in some cases aggregating to as much as 75 feet of casing being removed! The operation permitted coming back from depleted lime production in order to fracture tight sands at shallow depths with nitro-glycerine.

Adapted to Many Uses

Almost immediately greater demands were placed on the tool than ever foreseen. With the tool's ability to remove complete sections of casing, one of its greatest uses was for side-tracking off a whipstock in open hole. Here it answered the need to eliminate the hazardous method of side-tracking through a slotted window in casing which sometimes hung or damaged expensive drill pipe. It provided an open

hole for acidizing, for gravel packing, for setting screen against virgin sand, for by-passing stuck liners, and for salvaging stuck or twisted casing.

Discovery Led To New Tool

In 1949 a new tool came off the drawing boards of the A-1 Engineering Research Department. Basically it retained the same general principles of operation and construction as the one perfected by S. Robishaw. Continuing his father's pattern, Earl Robishaw noted from many operations that when the old tool milled off-center, a greater rate of milling and full use of the knives were obtained. By addition of a guide rib, which actually threw the mill off-center, and longer, heavier knives, Robishaw's ideas jelled into what is now called the Eccentric Guide Casing Mill.

From its first tests in September, 1949, on N-80 grade casing, the Eccentric Guide Casing Mill has proved Earl Robishaw correct by increasing the mill's efficiency 100% (sic). The new mill has now been adopted as tested and proven, but even today new features are being worked out which indicate higher milling rates than ever thought possible.

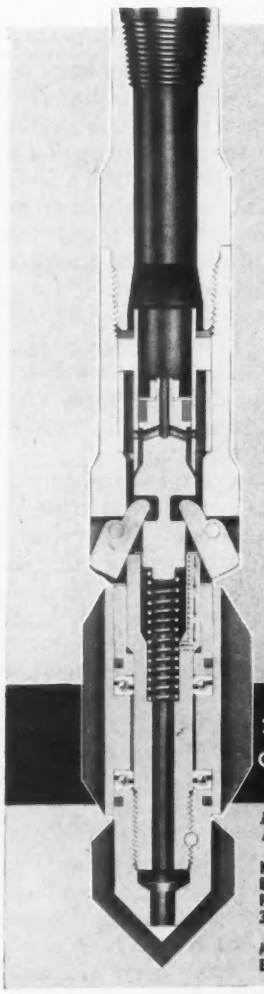
Operation of Tool

In operation the present Eccentric Guide Casing Mill is lowered through the casing to the highest point where open hole is desired. Slow rotation is started and pump pressure is gradually applied. A piston centered in the tool partially restricts circulation. The resulting hydraulic pressure acts on the piston which in turn forces a set of knives to expand upward and outward at the same time. Each knife, working as a lever on a pin, is forced to expand against the casing, cutting it out. When the knives have cut completely through the casing, the piston reaches its limit of travel, exposing circulating ports for free circulation. Constant weight, rotary speed, and pump pressure are maintained according to the grade of pipe, and milling is continued until the desired section is removed. When completed, the knives automatically collapse as they contact the casing at the top of the milled out section.

This operation is offered domestically on a job service basis by the A-1 Bit & Tool Company of Houston, Texas. Operators with years of drilling experience take complete charge of the job. So positive are the results that on sidetracking jobs A-1 makes a guarantee of "no window no pay." Specifications, brochures, and additional information may be obtained from the company's Houston office or from one of its many service points.

Advertisement

the Eccentric Guide is **EXCEPTIONAL!**



Introduced in 1949 with larger knives and a guide rib causing the path of rotation to be off-center, the Eccentric Guide Casing Mill cuts with a sawing action. It has shown a 100% improvement over the old Multi-Knife mill: A higher milling rate is obtained by the sawing action plus three times more use out of each knife.

ECCENTRIC ROTATION

Bottom view of new mill in action showing path of rotation off-center.

A typical dull knife from new mill. Note full use of heavier knife.

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A-1

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About the Author

GUY H. WOODWARD obtained his law degree from the University of Oklahoma and is a practicing attorney of many years experience in oil matters. After service to many oil companies, and several oil trade groups, he became executive assistant to the late Sen. Edward H. Moore of Oklahoma during which time he studied legislation dealing with factors that make for long-term availability of oil and gas. He is counsel for Noble Drilling Corporation and other Noble interests.

oil and gas reservoirs, and employing numerous scientific aids to bring about the extraction of oil and gas from the subsurface formations in which they are found.

It is not the known and proved reserves that have been drilled that insures our future supply, but the ability of the petroleum industry to perpetuate itself, and in so doing to perpetuate the supply, that must be depended upon.

If the industry is permitted the freedom to compete for profits and the freedom to retain sufficient profits to expand operations as required to meet demands, the long-term availability of petroleum supplies in this country will be assured.

So far, the petroleum industry has assumed and adequately discharged its full share of the responsibility of supplying U. S. energy requirements without subsidies or other governmental aid. Under the emergencies of war, some have thought that a degree of governmental control was necessary for the proper functioning of the industry and the distribution of its products. Whether or not these controls have assisted the industry in meeting its obligations in these emergencies is, to say the least, a debatable question. Be that as it may, under the present peacetime preparedness program, there is no reason to burden industry with the strict controls that have been imposed. At the end of the past year more than 20 control agencies had been established since the U. N. commenced its so-called police action in Korea. Some 700 basic price orders and literally hundreds of thousands of individual orders have been issued. The Wage and Salary Stabilization Boards are log-jammed with more than 8000 pending cases before each board. Production and allocation controls of steel, copper, aluminum and other critical metals are slowing some civilian industries to subnormal levels. The draft and recall to military service of trained or skilled employes is developing serious inefficiency in all phases of industry. Research and experimentation are definitely being retarded.

If industry were given a freer hand, it would discharge its responsibilities more expeditiously, with greater efficiency and far less waste of time and money than will otherwise be possible under stringent and confusing government controls.

Notwithstanding the devastating results to be suffered in production, scientific advancement and the lag in meeting schedules by reason of the many control boards and commissions to whom industry is answerable, the greatest deterrent to the long-term availability of petroleum products—and as a matter of fact, all production—is the confiscatory federal income tax rates that have been levied. Especially deplorable is the demand of the Treasury that the petroleum industry be taxed on its capital gains by abolishing the depletion allowance. If the capital gains realized from the sale of crude are to be taxed without the benefit of the depletion allowance, then the present treatment for gains realized from the sale of all capital assets should be abolished, because the sale of oil by the barrel from day to day is no different from the sale of the lease from which it is produced as a single transaction.

Gross assets of the petroleum industry are in the order of approximately $35 billion. About $27 billion are fixed assets representing the industry's investment in property, plant, and equipment before depreciation, depletion, and amortization reserves are deducted. Gross investment of the industry may be roughly divided as follows: production, 56 percent; refining, 18 percent; transportation, 13 percent; marketing, 12 percent; and miscellaneous, 1 percent. Capital expenditures since the end of World War II at the rate of approximately $2 billion per year have been required to keep pace with growing demands; yet only about 6.8 cents of every income dollar have been available for re-investment in the business. The balance has gone largely for taxes, payrolls, materials and supplies, and interest and dividends. The industry has, therefore, been forced into the money markets to meet its capital requirements. During 1950 taxes generated by the oil industry approached $4 billion, approximately $1.5 billion of which fell directly upon the industry. This is equivalent to about 75 percent of the recent annual average of the industry's total capital expenditures. Direct taxes during 1951 were even higher, and during the coming year the industry will probably be required to pay direct taxes in the order of $2 billion, or even more; yet after paying that bill, the industry will also have to provide sums probably well in excess of that amount to cover its necessary capital expenditures during 1952.

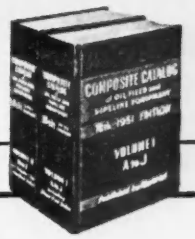
Obviously the freedom to use money generated in the petroleum industry is being seriously curtailed. No industry can long survive when borrowings replace re-investment of earnings. Unless industry is permitted to retain enough of its earnings to replace depreciation and depletion, pay stockholders a fair rate of return, and at the same time expand production and capital facilities to meet the growing economic demands, it is certain that the heyday of American industrial expansion no longer exists.

Government budget outlays are estimated at nearly $70 billion for the current fiscal year ending June 30, 1952, and more than $82 billion for the next year. By June 30, 1853, the Federal Government will have spent about $402 billion since the end of World War II, which is $88 billion more than the total spent during the war. It is $235 billion more than our government spent from 1789 through 1940. When analyzed in terms of our individual participation, this is a staggering amount. Twenty years ago government cost the average American family less than $200 annually; in 1950, government cost the average American family about $2000; and this will increase to about $2250 during 1952.

Many are convinced that the ability of private industry to add to the wealth of this country in the future depends directly upon the extent to which the tax rates are lowered. In other words, we have actually reached the point of diminishing returns. This seems to be substantiated by the fact that the last quarter's corporate income is reported at about $45 billion, or more than $10 billion less than the previous quarter.

NEW AND IMPROVED EQUIPMENT

SUPPLEMENTING COMPOSITE CATALOG



KEEP INFORMED by requesting additional information on new equipment and services described on this and following pages. SAVE TIME by using one of the free and convenient Reader Service Postcards on opposite page. Circle number on card corresponding to the number listed at the end of each new equipment item on which you desire additional information.

Corrosion Inhibitor

This item supplements Visco Products Company data on page 4983 of Composite Catalog, 18th Edition.

Visco 953X, a polar-type organic material marketed by Visco Products Company, is a new chemical inhibitor for corrosion control in oil production. It has the property of being absorbed on metal surfaces to form a lasting film which is impervious to the attack of most corrosive agents. Visco 953X is a complex synthetic composition having medium fluidity at atmospheric temperatures. It contains no inorganic salts or alkalis, and is a bland, dark-colored liquid with no corrosive or hazardous properties. It is basic in reaction, with a pH of approximately 9-10, and is soluble in oil and dispersible in water.

Circle No. 15 on Postcard

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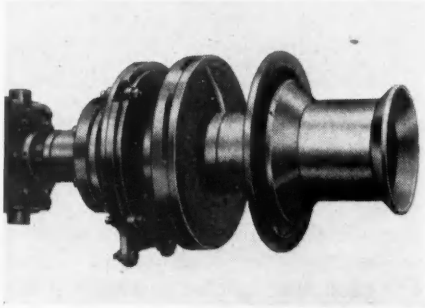
Cathead

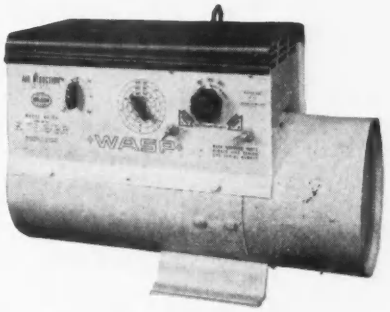
This item supplements Wichita Falls Foundry & Machine Company data on pages 5094-5097 of Composite Catalog, 18th Edition.

Embodying the qualities of the Air-Tube Disc Clutch, Witchita Falls Foundry & Machine Company's Air-Tube cathead is said to make up all



joints exactly alike. It is capable of pulling all the line will safely stand without breaking. The same cathead can be used for either spinning or breaking out, and all parts are interchangeable. With a new, quick-fastening line connection and a brake, the cathead can be used with a wire line as a hoist to drag in joints of pipe, pick up heavy loads, etc., instead of using manila rope.

Circle No. 16 on Postcard



Arc Welder

This item supplements Air Reduction Company, Inc., data on page 159 of Composite Catalog, 18th Edition.

New Model GA "WASP" direct current arc welders, available in 150 and 200 ampere sizes, are being marketed by Air Reduction Magnolia Company, a division of Air Reduction Company, Inc. Volt ampere characteristics of the machines make them especially suited to d-c straight Polarity Heliwelding with Thor-Tung, the manufacturer says. Continuous overlap from each current range to the next provides a wide, unbroken range of welding current—30 to 250 on the 200-ampere welder and 20 to 185 on the 150-ampere machine.

Circle No. 17 on Postcard

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Oxygen Generator

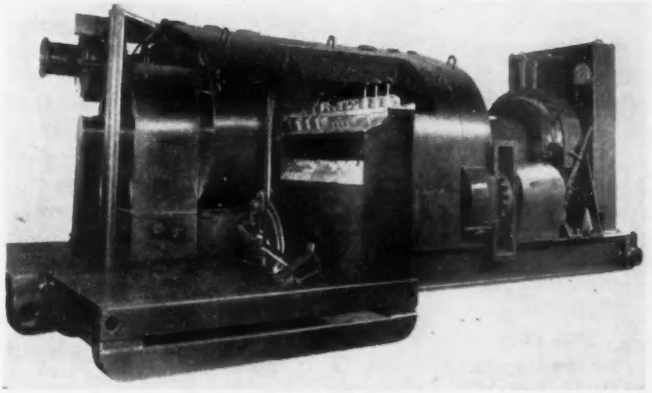
This item supplements Joy Manufacturing Company data on pages 2625-2644 of Composite Catalog, 18th Edition.

A semi-portable oxygen generator that will enable industrial users to produce their own high purity oxygen at reported savings up to 50 percent has been announced by Joy Manufacturing Company. The compact unit uses only air and power to produce oxygen at an operating cost of 5 to 10 cents per 100 cubic feet. Heart of the oxygen generator is a series of automatic reversing heat exchangers which eliminate the expense of chemical purification of the air.

Circle No. 18 on Postcard

Packaged Rigs for Medium and Deep Drilling

This item supplements Emsco Derrick & Equipment Company data on pages 1489-1608 of Composite Catalog, 18th Edition.



Emsco Derrick & Equipment Company is manufacturing two new rigs, the J-1100 and J-1400, for medium to deepest drilling. Both have Emsco's "packaged design," with drawworks, selective speed transmission, compounding transmission and sand reel optional and independent of drawworks—all skid mounted and packaged separately in eight-foot roadable widths. Independent selective speed transmission eliminates long chain and V-belt drives, and makes possible four different setups. Optional washdown pump drive package is available to mount on the driller's end of the input shaft of the transmission. All air controls and gauges are mounted in a console. Both J-1100 and J-1400 are alike in design and operations, but dimensions of J-1400 are slightly larger. Both rigs are offered with mechanical, fluid-coupling or electric coupling drives and are adaptable to torque converter drives.

Circle No. 19 on Postcard

NEW EQUIPMENT

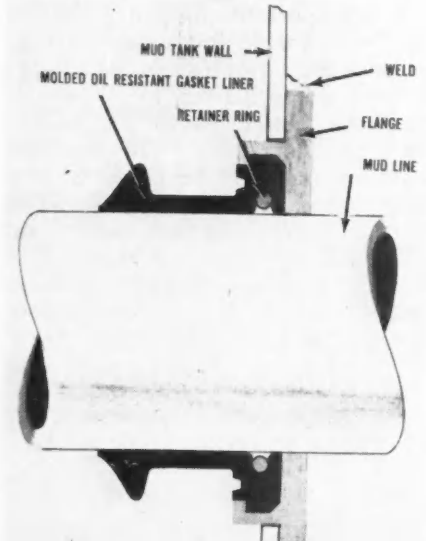
SUPPLEMENTING COMPOSITE CATALOG

To obtain additional information use convenient Reader Service Postcard on page 71. Circle number on card corresponding to number listed at the end of each new equipment item on which more information is wanted.

Connector

This item supplements Byron Jackson Company data on pages 937-1036 of Composite Catalog, 18th Edition.

Byron Jackson Company's new PB Flexline connector is a simple connection which allows the use of plain end pipe for connecting two mud tanks or between the pump suction and a mud tank. It provides positive, leak-proof sealing and allows for angular variations as much as 10 degrees. Since plain end pipe can extend into a tank as far as necessary, the need for spotting tanks the same



distance apart on each location is eliminated. The connector consists essentially of a steel flange welded to the mud tank, a molded packing element, and a retainer ring. It is made for 8⅝- and 10¾-inch pipe.

Circle No. 20 on Postcard

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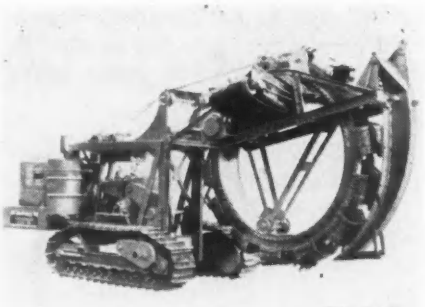
Ditching Machine

This item supplements Parsons Company data on page 4163 of Composite Catalog, 18th Edition.

A special pipe line Trenchliner, Model 215, is available from Parsons



Company with a choice of two standard make 55-horsepower diesel engines. It has six digging wheel speeds up to 11.2 revolutions per minute; 30 digging feeds from 6.2 inches to 18.5 feet per minute; nine trenching widths from 13 to 31 inches wide, and up to six feet deep. Standard-make, tractor-type crawlers have lug-type shoes, and 18-inch treads. Ground bearing pressure is approximately six pounds per square inch. Model 215 has friction clutch control of digging wheel, self-sharpening "Tap-In" digging teeth, shiftable and reversible belt conveyor for discharging spoil on either side of machine.

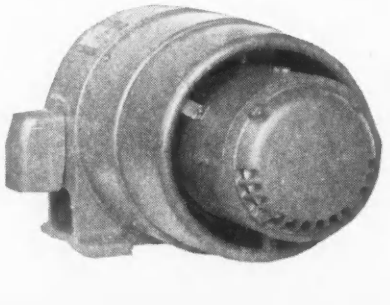
Circle No. 21 on Postcard

•

Synchronous Generator

This item supplements General Electric Company data on pages 1809-1820 of Composite Catalog, 17th Edition.

Available in four basic designs, a new line of General Electric Tri-Clad high-speed synchronous generators have ratings from 1.875 to 50 kva. The generators, designated as types ATI, ASI and ATB, have frequency ratings of 60 and 400 cycles. Three standard types of 60-cycle generators are offered, providing a range of characteristics for several different categories of voltage regulation and motor starting requirements. Variations of the basic machines are available with special characteristics for special applications.



The basic 60-cycle design is an externally regulated generator for operation with standard voltage regulator in the exciter field circuit. A modification of the basic line provides self-regulated features for applications where average voltage regulation and motor starting ability is desired. A third line involves the basic 60-cycle generator, and a special overhung amplidyne exciter, and a static voltage regulator.

Circle No. 22 on Postcard

•

Plastic-Glass Fiber Pipe

This item supplements Perrault Brothers data on page 4179 of Composite Catalog, 18th Edition.

Perrault Brothers has introduced a tough, lightweight, flexible pipe with applications for crude lines, oil well

tubing, gas distribution lines, water systems, and oil products lines, among other uses. "Fibercast" is a thermo-setting, glass fiber reinforced, plastic pipe which will not shatter and does not melt under high temperatures. The pipe need not be coated or given any other cathodic protection, and can be placed by hand or with light machines and joints bent to conform with ditch contours. Once bent it will return to form when released. The pipe is not affected by temperatures ranging from —65° to + 300° F. The largest size now available is 4½-inch, with a rating of 400 pounds working pressure and weight of 39 pounds. Tubing of that size weighs 52 pounds.

Circle No. 23 on Postcard

OTHER NEW AND IMPROVED EQUIPMENT

KEEP INFORMED by requesting additional information on new equipment and services described on this and following pages. SAVE TIME by using one of the free and convenient Reader Service Postcards on page 71. Circle the number on card corresponding to the number listed at the end of each new equipment item on which more information is wanted.

Paraffin Solvent

"Sol-Treet" is a new paraffin solvent compounded by Mid-State Chemical Company, Inc., for use on pumping wells, recycling operations, flow lines, tank bottoms and flowing wells. Sol-Treet retains the dissolved paraffin in solution, the manufacturer claims, because the chemical reaction breaks down the molecules which make up paraffin.

Circle No. 24 on Postcard

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Oil-Resistant Tape

A new oil-resistant tape for rapid insulation build-up on splices in large power cables is being made by Minnesota Mining and Manufacturing Company. Designated "Scotch" brand

electrical tape No. 25, it is made of synthetic rubber, proving greater dielectric strength and resistance to high temperatures than natural rubber tapes, the manufacturer states. Since it fuses to itself, forming a solid homogeneous mass, it requires no adhesive.

Circle No. 25 on Postcard

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Rubber Cement

Nerva-Plast cold setting cement, made by Rubber and Plastics Compound Company, Inc., is a heat-insulating compound which also resists corrosion. Made of rubber and asphaltic hydrocarbons, the cement, on drying, forms a tough, resilient, unbreakable elastic film.

Circle No. 26 on Postcard

Transformer

"Donut" instrument current transformers, made by Associated Research, Inc., are now available in new Model 321 series, with maximum outside diameter of five inches; minimum inside diameter of 2.25 inches; and maximum thickness of 1.75 inches. Capacity is 2.5 volt ampere, and accuracy is rated at 1.2 percent. The transformers are intended for use with ammeters, relays or other devices where phase angle is not important.

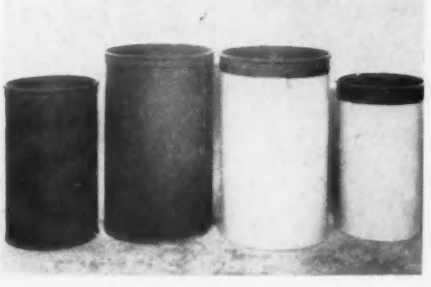
Circle No. 27 on Postcard

•

Rubber-Lined Drum

A standard line of 30- and 50-gallon rubber-lined drums has been developed by Latex Dipped Products Company. Blue Diamond drums are lined with ⅛- or 3/16-inch, 5-ply, 70-shore (semi-hard), smooth, non-porous, uncured natural rubber which is both abrasion and chemical resistant. The lining consists of five plies, each .047 inch thick, which are fused together in the curing process for complete coverage of the metal. The drums are available with inside lining only or with both inside and outside lining.

Circle No. 28 on Postcard



Transformer

Miniature transformers and reactors manufactured by Southwestern Industrial Electronics Company are components for geophysical instruments said to be characterized by high performance, light weight, close electrical tolerances, good shielding and true hermetic sealing. Dimensions of the three-ounce units are 15/16 x 1⅛ x 1⅞ inches.

Circle No. 29 on Postcard

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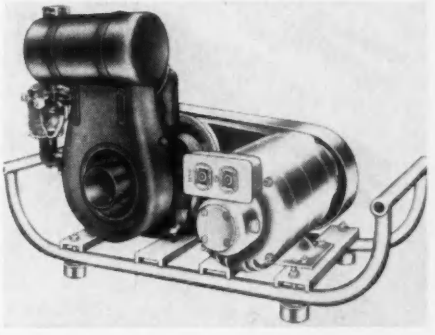
Electric Generator

Wincharger Corporation has developed a portable gas-engine drive electric generator, Model 1800, in three general ratings—100, 1250 and 1350 watts at 115 volts, 60 cycles, alternating current. The generator has



sealed ball bearings, and its belted construction cushions shock to the generator, reduces vibration and increases the generator life, the manufacturer claims. Generator is mounted alongside the engine, out of the path of hot air from the cooling system. Universal mounting base is provided.

Circle No. 30 on Postcard

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Phenolic Resin

Phenoline 300, a modified phenolic coating resin manufactured by Carboline Company, may be applied by brush, spray or trowel to protect structural and mechanical equipment against corrosion. The material resists acids, alkalis, and solvents such as straight chain and aromatic hydrocarbons and chlorinated hydrocarbons. The coating sets hard at room temperature.

Circle No. 31 on Postcard

To obtain additional information use convenient Reader Service Postcard on page 71. Circle number on card corresponding to number listed at the end of each new equipment item on which more information is wanted.

Concrete Paint

Smooth-On Manufacturing Company offers a new concrete paint, No. 15, for use on interior or exterior concrete, cement block, brick and stone. It does not require primers or sealers and can be applied to painted or unpainted, dry or damp surfaces. One gallon covers approximately 400 square feet. It is resistant to water, acid or alkaline attack.

Circle No. 32 on Postcard

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Metal Cable

Pneumatic and hydraulic control circuits can be streamlined by use of Bailey Meter Company's Armortube cable, a flexible, protected multi-tube transmission line. The cable is made up of quarter-inch o. d. aluminum

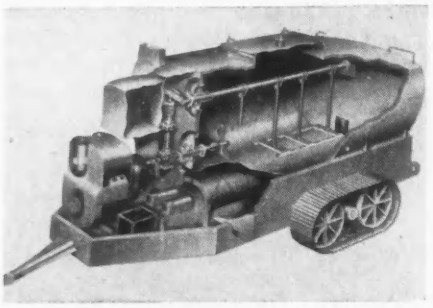
or copper tubing gathered in a slow continuous spiral similar to the construction of rope. The tube bundle is first wrapped in water-repellent insulating tape; then encased in heavy rust-resistant, galvanized steel strip like that used for BX electrical cable. The cable is capable of transmitting hydraulic control pressures as high as 3000 psig and all ranges of pneumatic control pressures.

Circle No. 33 on Postcard

•

Dope Kettle

Crutcher-Rolfs-Cummings, Inc., has placed on the market a new dope kettle, Model "SP," which accomplishes double agitation by means of a marine type propeller plus a slow speed bottom sweep. Another innovation is the combustion chamber which



has a double gas pass for bottom protection and fuel economy. Insulation is provided by a two-inch thickness of rock wool over all exposed surfaces, and a plug-type draw-off valve is kept warm by a hot dope jacket which prevents freezing during shutdown periods. Coke formation is prevented by a constant sweeping action, actuated by a heavy-duty hydraulic cylinder, across the bottom of the kettle.

Circle No. 34 on Postcard

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Torque Motor

An electromechanical actuator, the Model 8 torque motor, was designed by Midwestern Geophysical Laboratory primarily to stroke hydraulic servovalve pistons. It is usually driven from a servoamplifier utilizing two output tubes in push-pull. This actuator produces more than five inch-pounds of torque at a radius of .906 inch with 40 ma differential current in its two coils (2900 ohms each). It has a maximum stroke of ±.020 inch, and less than 2 percent hysteresis. The motor weighs 18 ounces, and has a no-load natural frequency of 425 cps.

Circle No. 35 on Postcard

Cleaning Compound

A new type of steam cleaning compound, Magnus 72 made by Magnus Chemical Company, contains no alkaline salts. The non-corrosive compound generates no objectionable fumes and can be used indoors. It will not clog steam cleaning equipment, due to its unsaponified oil content, which works to prevent rust formation on unprotected metal surfaces.

Circle No. 36 on Postcard

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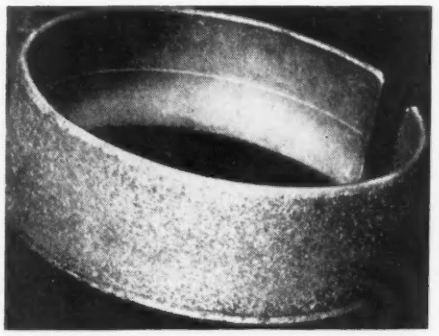
Metal Bands

Diamond Hard Metal Bands are diamond-hard protective drill string collars made by Diamond Hard Metal Products, Inc. The bands, made by a rolling process of the hardest commercially known hard-facing mate-



rials, offer a combination of abrasion resistance with ductility. The bands can be applied to tool joints and drill collars, in shop or field, by regular crews using ordinary welding techniques. The bands are applied on badly worn joints by arc-welding flush on the outside surface, and on new joints by countersinking below the surface.

Circle No. 37 on Postcard

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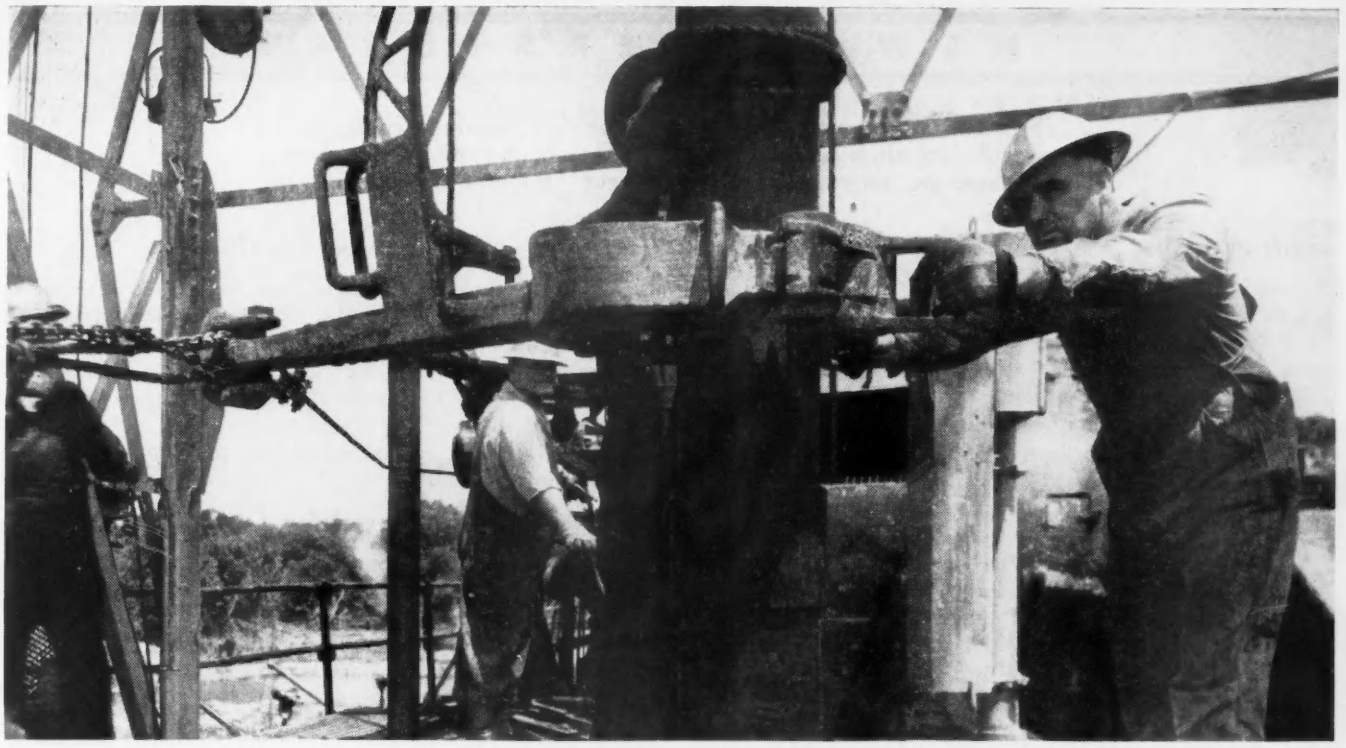
Aluminum Tubing

Aluminum Company of America has introduced a new general purpose aluminum coiled tube, Alcoa Utilitube, made of aluminum alloy B50S-O. Having good flaring and forming characteristics, the tube bends more easily than annealed copper and work hardens less under repeated bending. It is resistant to vibration and corrosion in many exposures, and improves in mechanical properties at sub-zero temperatures.

Circle No. 38 on Postcard



REMINDERS OF GOOD CASING PRACTICES:

How to Test for Proper Make-Up

A supplemental method for determining the effectiveness of make-up is to place the bare hand on the coupling at frequent intervals; when the proper method is being used, the coupling will get uniformly warm. A hot spot on the coupling is an indication of galling.

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REPUBLIC
Electric Weld Casing and Tubing

★ Make Up Fast
★ Resist Collapse
★ Resist Pull-Out

These oil country tubular products are uniformly round, uniformly strong, uniformly straight, and uniform in wall thickness. Each length is cold-formed from high ductility steel, fully normalized for uniform structure. Casing is cold sized to further increase its high yield strength. Clean, full-formed threads stab, spin-in and tong-up fast . . . and tight. The uniform depth of tough steel under thread roots all around the pipe protects against pull-outs. Literature on request. Write:

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NORMALIZED CASING AND TUBING

Other Republic Products include Line Pipe—Carbon, Alloy and Stainless Steels—Upson Studs, Bolts and Nuts—Electrunite Heat Exchanger Tubes

NEW LITERATURE

Copies may be obtained easily and without cost by using Reader Service Postcard. Just circle on the card the number at the end of each item in which you are interested. The convenient Postcards are on page 71.

Long-Wearing Parts

Cast and wrought alloy parts are the subject of a new 24-page booklet, "Long-Wearing Machinery Parts," issued by Haynes Stellite Company. The parts are made of various Haynes cobalt, iron, and nickel-base alloys.

Circle No. 39 on Postcard

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Burners

Cleaver-Brooks Company has issued an eight-page catalog describing its complete line of Hev-E-Oil burners, and illustrating the various sizes and capacities of the burners.

Circle No. 40 on Postcard

•

Processing Equipment

Selas Corporation of America's new bulletin, describing the application of a wide range of equipment to precision processing of fluids, illustrates eight types of equipment.

Circle No. 41 on Postcard

Inspection Services

Increased commercial inspection service and testing consultation are the subject for new bulletins issued by the Magnaflux Corporation. The firm's technical services are fully described, with a discussion of techniques and instruments used in examination for evidence of defects in metal. Numerous photographs show laboratory and field units at work.

Circle No. 42 on Postcard

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Recorder

Protection of pipe line pumping units against excessive temperature is covered in a new four-page bulletin published by the Minneapolis-Honeywell Regulator Company, Brown Instruments Division. The system uses multi-point ElectroniK recorder for logging motor and pump temperatures.

Circle No. 43 on Postcard

Water Treatment

Infilco, Inc., has issued a new bulletin describing its packaged water treatment unit which handles 5 to 100 gallons per minute. The unit softens, clarifies, sterilizes or removes organic matter, tastes or odors.

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•

Scientific Cleaning

Scientific cleaning and processing through pH control is the subject of a new brochure issued by Kelite Products, Inc. This booklet deals with typical cleaning jobs in all phases of the industry.

Specific jobs covered include removal of crude, grease, rust, scale, paint, etc., cleaning fuel oil or storage tanks, reconditioning oil tools, valves and machinery parts, descaling or desludging of heat exchangers.

Circle No. 45 on Postcard

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Turbines

The Pyle-National Company has released six new bulletins describing the line of high-efficiency impulse type steam, gas or air turbines for mechanical drive, ranging from ¼ to 120 hp.

Circle No. 46 on Postcard

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Squirrel-Cage Motors

Squirrel-cage induction motors are described in a new bulletin, "Allis-Chalmers Large Squirrel-Cage Induction Motors." The motors are available in ratings and speeds up to 1750 hp at 1800 rpm.

Circle No. 47 on Postcard

•

Industrial Furnaces

Westinghouse Electric Corporation's new 38-page booklet, "Harnessing Heat," tells how to match a furnace to one's particular heat-treating problem.

Circle No. 48 on Postcard

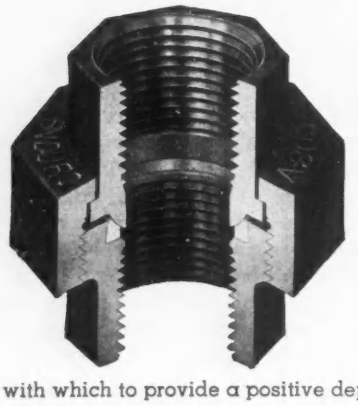
•

Lubricants

A new eight-page booklet on UCON brand synthetic lubricants can be obtained from Carbide and Carbon Chemicals Company. The non-sludging synthetic lubricants have high-temperature applications.

Circle No. 49 on Postcard

Jefferson Malleable Unions



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There Is Room Enough and Time

By FRANK A. MORGAN

Richfield Oil Corporation, Los Angeles

Past President, American Association of Petroleum Geologists

THE OIL INDUSTRY is young. It is just about 90 years of age.

That's not very long for a product which so influences world affairs; which is now being produced at a rate of 12 million barrels per day.

Considering the importance of oil in fueling and lubricating the earth, it must be realized that 90 years is just a beginning. A single human life span often extends that long.

Man has been around for quite a few centuries. Some say 250,000 years; some believe it is only 40,000; but, however it is, it must likewise be just a beginning.

Although we have witnessed many advancements in the oil industry during recent years we cannot overlook the fact that technological improvements are occurring at a perceptible rate at this very moment; improvements in the science of oil finding and in drilling, production, transportation, manufacturing and utilization.

It must be that the ultimate in the rate of development of the science of oil finding is yet some distance ahead. It may be an unbelievably long time ahead with records to be established which are at this moment undreamed of.

The pessimist says, "It is later than you think." The geologist, when viewing the application of resourcefulness to the boundless realm of knowledge and science, must conclude that the reverse is true—"It is earlier than you think!"

• • •

THE FACTS reveal that we are now witnessing spectacular new peaks in the sciences of transportation and communication.

Witness the rocket planes racing ahead of sound. That's transportation. Just a few months ago many experts considered this scientifically impossible and some actually proved it—on paper. How early it was, relatively, when man could fly only 700 miles per hour, just below the sonic barrier. Who called it a *barrier*?

Or witness the Rose Bowl game in 1952, played in the sunshine and instantaneously reaching the eyes of millions of people after dark in the Eastern U.S. That's communication.

Besides proving the point that new records remain to be established, it is important to note that transportation and communication mean an acceleration in the shifts of population from one place to another in the world, and in culture and education.

These conditions explain to a large degree why the consumption of petroleum in the U.S. is about 15 barrels per capita per year, while in all other parts of the world outside of the U.S. the consumption of petroleum is less than 1 barrel per capita per year.

When the opportunity for change in this fast moving world, affecting more than 2 billion people outside of the U.S. is considered, it must be that we are still very youthful in this petroleum industry, both as to its responsibilities and its opportunities.

If, through advancement in transportation and communication, in education and culture, the people outside the U. S. should increase their consumption of petroleum just 1 barrel per person per year, then the world's requirements will increase 53 percent or from 3.8 to 5.8 billion barrels per year.

I do not know what this would do politically in this strife-torn world, but this is the kind of an advancing society in which we live.

Such is the opportunity and the responsibility of the oil industry. Such is the job of the petroleum geologist.

He has plenty of room in which to look.

Paleofacies—The Geologist's New Tool

By T. H. PHILPOTT

The Carter Oil Company, Shreveport

Past President, Society of Economic Paleontologists and Mineralogists

IT HAS BECOME increasingly apparent that the nation's important petroleum reservoirs of the future will be controlled by porous limestones and sand lenses associated with structural terraces and noses rather than faults and anticlines. It therefore follows that added variables which cannot be detected from the surface will make the job of the exploration geologist even more complex and costly. Obviously, a direct method of finding oil would solve our problems. A great deal of work and money is being expended currently in search of such a method. However, let us be realistic. It is recommended that the gaps in the oil exploration procedures be integrated, using present techniques, with the assignment of equal responsibility to the geologists, geophysicists, paleontologists and mineralogists.

For a case in point, it is recognized that the geologist might gain a better viewpoint of the work carried by the paleontologist. Four words have been coined for the purpose of subdividing the field of paleontology as used by the economic geologist. Let us outline briefly the types of organisms that are being used currently in the field of paleontology.

The field of orthropaleontology (a coined word) signifies the finding, naming, describing and the biological classification. On the other hand, we have the field of cyrtopaleontology (also a coined word) meaning utilization of fossils. The cyrtopaleontologist is not interested in taxonomy; generally a letter or number will suffice for identification. Most of our oil company paleontologists fall in this latter group. The term pliomacropaleontology is introduced to include most of the larger forms that have been studied in great detail by the orthropaleontologist. Most of these groups can also be found as smaller forms and herein would be classified as miomacropaleontology. Many geologists and paleontologists recognize the latter groups as small, immature, dwarfed forms; however, it is thought that many are fully developed, adult forms, and consequently a whole new subsurface field awaits investigation.

A similar division may be made in micropaleontology with most of the forms used today being classified in the field of pliomicropaleontology. The importance of microforaminifers, diatoms and pollen will be determined by future study and research.

Generally speaking, a large part of the micropaleontological work being done is based upon key fossils; that is, those widely distributed geographically and with a supposedly short stratigraphic range. This standard procedure omits a large and important element, together with the milieu (surrounding environments), from consideration in the over-all picture. On rare occasions, a small percentage of the micro-faunal population is considered on the basis of abundance, the host rock, types, evolutionary development or sequence. Single factors seldom are decisive, but a group of factors may lead to important solutions and conclusions.

• • •

LAST YEAR IN ST. LOUIS, the SEPM presented "A Symposium on Paleoecology of Shale and Evaporite Deposition". Samuel P. Ellison, Jr., pointed out that "workers in the field of micropaleontology have not consistently tied lithology and fossil occurrences together. Twenty-three percent of the papers in the 11 volumes of the *Journal of Paleontology* 1940-50, failed to mention lithology. An excellent example on how this data should be handled is shown by D. M. Loranger in "Useful Blairmore Microfossil Zone in Central and Southern Alberta, Canada" which appeared in November, 1951, *Bulletin of the AAPG*.

Some research is being done on the ecology of the living foraminifera. Important contributions have been made by F. B. Phleger, S. W. Lowman, M. L. Natland and others. Lowman, Natland, M. C. Israelsky and L. J. Wilbert have reported on investigations into paleoecology.

Let us review briefly the present procedures in subsurface geology. Samples are brought in from the field to the laboratory and after due processing, are turned to the paleontologist—stratigrapher. Normally the key or index fossils are reported to the subsurface geologist. This procedure is satisfactory where only structural prospects are being worked. If the information fits the general conditions, it is assimilated and used as evidence to support pre-existing correlations.

In the case of changes in stratigraphic facies, or paleofacies, pertinent data are seldom reported or understood. In many cases the present handling of data could be vastly improved by having the cyrtopaleontologist combine his information with pertinent geological information. The subsurface and the administrative geologists should have a better understanding of the problems and information that the paleontologist can provide. Single geological or paleontological factors are seldom decisive, but a better understanding of the biozone and its environment may lead to a clearer understanding in oil finding problems.

Geophysical Exploration Comes of Age

By SIGMUND HAMMER

Gulf Research and Development Company, Pittsburgh
Past President, Society of Exploration Geophysicists

IN TERMS of the history of science and technology, geophysical prospecting is very young. The modern age of geophysical prospecting can fairly be said to have begun in 1915 when an Eotvos torsion balance survey successfully extended the deep flanks of the Egbell structure in Czechoslovakia. This was apparently the first deliberate application of geophysical prospecting, in the modern sense, to oil-finding. The idea of applying geophysical measurements in the search for oil could hardly have occurred sooner because (according to DeGolyer) the year 1913, two years earlier, marks the beginning of the acceptance of geology as a guide to prospecting. Most of us realize how vast is our present profession. Few realize how quickly it has developed.

Geophysical exploration is professionally concerned with all geological exploration problems. The applications to explorations for petroleum are well developed. Last year, official SEG records show, about $325 million was invested in world-wide geophysical explorations by the oil industry alone. This represents a phenomenal increase of $100 million over the 1950 investment—an increase of nearly 50 percent. The rate of increase in geophysical exploration for oil exceeds the rate of increase in the total petroleum exploration effort.

The commercial acceptance of geophysics is justified by its success. Lahee's well-known annual statistics report the success expectancy of a wildcat well drilled in the U. S. in the hope of discovering a new oil field for various bases of selecting the drilling site. Rounding out the small annual fluctuations (which are not significant for our purpose) these statistics give the following average success ratios for the past five years: (1) random drilling, 1 in 30; (2) geological locations, 1 in 10; (3) geophysical locations, 1 in 6; and (4) combined geological and geophysical locations, 1 in 5. The improvement resulting from the application of the best modern exploration technique—geology and geophysics working together—is very impressive. Compared to random drilling, the saving amounts to 25 dry holes per new-field discovery. This is an important factor in the present strong "reserves" position of the petroleum industry.

• • •

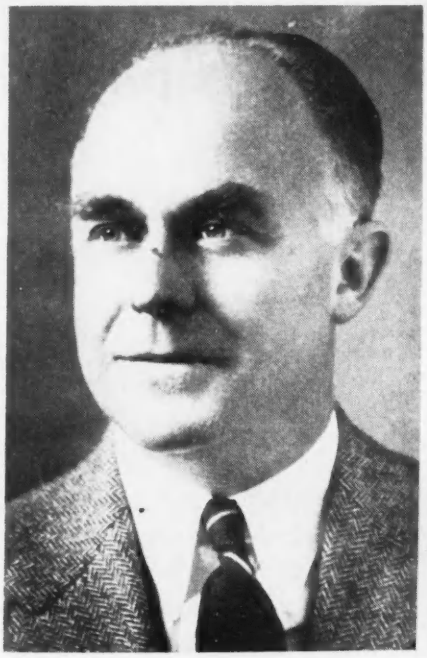
THE NEED TO MAINTAIN and improve the discovery effectiveness of our exploration techniques is urgent. We are often reminded that our proven petroleum reserves are only sufficient to supply the wheels of industry for about 20 years. Therefore, we cannot afford to slacken our efforts. Up till now, we have been able to keep up with the race. Last year, according to WORLD OIL statistics, the world produced 4¼ billion barrels of crude. However, the new oil discovered during the year, as now estimated, was 9 billion barrels, which is enough not only to replace the amount consumed but also to add several billion barrels to the "proven reserves."

Nevertheless, young men entering college are often deterred from choosing geophysics or petroleum geology as a career because they have heard the prophets of doom shouting about the impending shortage of oil. It is unfortunate that bright young men who could be expected to contribute much to the solution of future problems give heed to these dire predictions and are misled into other fields. Therefore, it is worthwhile to take a broader view.

The total amount of petroleum discovered throughout the world to date, including about 70 billion barrels produced and 80 to 100 billion barrels in the "proven reserves," is about 150 billion barrels. Estimates of potential world petroleum resources which remain to be discovered may be in the neighborhood of 600 billion barrels or four times as great. At an expected world-wide annual production rate of about 6 billion barrels, this should keep us in business for 100 years.

MORGAN J. DAVIS
President of AAPG

CLIFFORD C. CHURCH
President of SEPM



CURTIS H. JOHNSON
President of SEG

Exploration Societies Elect

Joint Sessions and Symposiums Highlight AAPG, SEG, SEPM Meeting in Los Angeles

HIGHLIGHTED by a joint session on March 25, and the election of officers, the American Association of Petroleum Geologists, the Society of Exploration Geophysicists and the Society of Economic Paleontologists and Mineralogists gathered in Los Angeles March 25-27 for their annual meeting.

Morgan J. Davis, vice president in charge of exploration, Humble Oil & Refining Company, Houston, became the 36th president of the AAPG for the 1952-53 term. SEPM named Clifford C. Church, Tide Water Associated Oil Company, San Francisco, as its 1952-53 president. Curtis H. Johnson, General Petroleum Corporation, Los Angeles, took over as president of SEG for the coming year.

Approximately 2800 men and 1000 women exchanged information and ideas. The three programs ranged from joint sessions and symposiums to field trips and banquets.

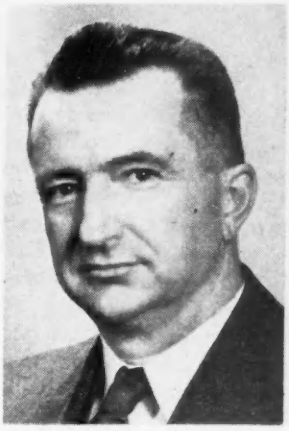
Howard C. Pyle of Jergins Oil Company, Long Beach, Calif., was scheduled to give the welcoming address. Another feature was to be an address by Eugene C. Holman, president of Standard Oil Company (N. J.), on "Our Inexhaustible Resources."

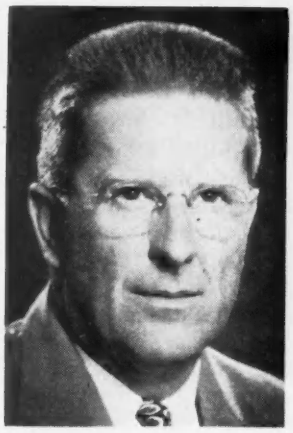
Scheduled for the joint sessions were talks by the retiring presidents of the three socities—Frank A. Morgan of AAPG, Sigmund Hammer of SEG, and Thomas A. Philpott of SEPM.

Commanding top interest on the AAPG program was a symposium on fractured reservoirs. Scheduled papers on this topic included: "Fractured Shale Reservoirs of California," by L. J. Regan, Jr., State Exploration Company, Bakersfield, Calif.; "Dynamic Role of Dilatancy in the Accumulation of Oil in Metamorphic Rocks: A Hypothesis," by Duncan A. McNaughton, University of Southern California, Los Angeles; and "Production from Fractured Rocks in the Northern Fields of Mexico," by Henry J. Morgan, Jr., The Atlantic Refining Company, Dallas.

Also "Some Consideration of the Performance of Fractured Oil Reservoirs" by Sylvain J. Pirson, Stanolind Oil & Gas Company, Tulsa; "Fractured Controlled Production in the Gilbertown Field, Alabama," by Jules Braunstein, Shell Oil Company, Jackson, Miss.; "Oil From Fractured Shale

Officers of the SEG are (left to right): Roy L. Lay, vice president; Carl L. Bryan, secretary-treasurer, and Paul L. Lyons, editor of *Geophysics*.





Officers of AAPG are (left to right): John G. Bartram, vice president; Robert H. Dott, secretary-treasurer, and Dr. Kenneth K. Landes, editor of *Bulletin of Petroleum Geology*.

Reservoirs in Colorado," by the research committee, Rocky Mountain Association of Geologists; "Evidences of Fractured Reservoirs in Wyoming," by H. Donald Curry, Shell Oil Company, Casper, and "Fracturing in the Spraberry Reservoir, West Texas," by W. M. Wilkinson, Sohio Petroleum Company, Abilene, Texas. Seven papers on fractured reservoirs were to be read by title.

The AAPG field trips to Cuyama, Bakersfield, the San Joaquin Valley and San Francisco were scheduled after the annual business meeting on the final day of the conclave.

The SEG's technical program included case history papers, reports on new methods and experimental projects. The report of the committee on geophysical activity headed by Dr. E. A. Eckhardt, Gulf Research and Development Company, Pittsburgh, and the "Review of Western Canadian Geophysical Activity Since 1948" by H. M. Houghton, Amerada Petroleum Corporation, Calgary, Alberta, Canada, provided a complete picture of world-wide work in geophysics during 1951.

Safety and Geophysical Exploration was the theme of the SEG's opening-day program. This topic was under the supervision of a special committee on safety, headed by Bert W. Sorge, United Geophysical Company, Pasadena, Calif. A variety of papers on magnetics, gravity and seismograph rounded out the program which was closed with a field trip to the California Institute of Technology.

SEPM Field Trip

The first day of SEPM's program included a field trip to the Palos Verdes Hills near Los Angeles. Joint sessions with the AAPG and SEG occupied the second day. This was followed by a Founders' Day dinner, commemorating the founding of the society 26 years ago. The program of general paleontology included eight papers, three dealing with foraminifera and foramiferal studies.

The theme of the March 26 meeting was "Objectives in Modern Sedimentology and Paleontology." General mineralogy was the topic discussed on the final day of the meeting.

Entertainment for members of the three societies and wives included cocktail parties, visits to radio broadcasting studios, theater parties and luncheons. As a prelude to the meeting, a group of oil exploration executives were to appear on television to discuss petroleum reserves and the responsibilities of the exploration groups.

John G. Bartram, consulting geologist, Stanolind Oil & Gas Company, Tulsa, was named vice president of the AAPG. Robert H. Dott, director, Oklahoma Geological Survey, Nor-

Officers of the SEPM are (left to right): Morton B. Stephenson, vice president, and Dr. Cecil G. Lalicker, secretary-treasurer.

Award winners at the exploration societies' meeting were Dr. E. A. Eckhardt (left), SEG Honorary Membership Award; Dr. L. Y. Faust (center), SEG Best Paper Award, and Dr. Raymond Siever (right), AAPG President's Award.

man, Okla., was reelected secretary-treasurer. Dr. Kenneth K. Landes, Department of Geology, University of Michigan, Ann Harbor, was renamed editor of the AAPG monthly, *Bulletin of Petroleum Geology.*

Executive Committee

This new slate of officers with Frank A. Morgan, vice president of Richfield Oil Corporation, Los Angeles, and retiring president of the group, will serve as the executive committee and direct the activity of the 8700 members for the coming year.

Retiring AAPG executive committee members are C. L. Moody, consulting geologist, The Ohio Oil Company, Shreveport, as past president (1950-51) and Lewis G. Weeks, chief research geologist, Standard Oil Company, (N. J.) New York City, as past vice president.

Morton B. Stephenson, Stanolind Oil & Gas Company, Houston, was named vice president of SEPM and Dr. Cecil G. Lalicker, University of Kansas, Lawrence, was reelected secretary-treasurer. Jack L. Hough of the University of Illinois, Urbana, was elected editor of the *Journal of Sedimentary Petrology* and J. Marvin Weller, University of Chicago, was named editor of the *Journal of Paleontology.*

Other SEG Officers

Besides president Johnson other new officers of the SEG are Roy L. Lay, The Texas Company, Houston, vice president, and Carl L. Bryan, consulting geophysicist, Shreveport, secretary-treasurer. Paul L. Lyons, The Carter Oil Company, Tulsa will continue as editor of *Geophysics.* These new officers, along with Dr. Hammer, will serve on the executive committee for 1952-53.

In addition to Dr. Hammer, retiring officers of SEG include: Johnson, past vice president and R. C. Dunlap, Jr., Geophysical Service, Incorporated, past secretary-treasurer.

The SEG honorary membership award for 1951 went to Dr. Eckhardt, vice president, Gulf Research and Development Company, in recognition of his many years of loyal support of the society. For several years, Dr. Eckhardt has been chairman of the committee on annual review of geophysical activity. He was president of the society in 1939-40.

Award to Dr. Faust

Dr. L. Y. Faust, Geophysical Research Corporation, Tulsa, received the annual "Best Paper Award" for his paper, "Seismic Velocity as a Function of Depth and Geologic Time," published in the April, 1952, issue of *Geophysics.* Dr. Faust received his doctorate degree in physics from the University of Pennsylvania in 1930 and since has been associated with the Geophysical Research Corporation and Amerada Petroleum Corporation. He is currently concerned with the study of special geophysical problems and seismic reinterpretation.

Dr. K. C. Heald, vice president, Gulf Oil Corporation, Pittsburgh, received the AAPG Sidney Powers Memorial Award in recognition of long and outstanding service and contributions to petroleum geology and for his leadership in research on oil's origin. Dr. Heald is a graduate of Yale University. He served as chief of the U. S. Geological Survey's oil and gas section in 1919, and after a year of teaching joined Gulf as chief geologist in 1925.

Dr. Raymond Siever, associate geologist, Coal Division, Illinois State Geological Survey, Urbana, Ill., received the AAPG President's Award.

Dr. Twenhofel Honored

The SEPM Award in Recognition of services went to Dr. W. H. Twenhofel, professor emeritus, University of Wisconsin, Madison. Dr. Twenhofel is a past president of SEPM (1935-36) and was elected an honorary member of AAPG in 1947, when he was editor of the *Journal of Sedimentary Petrology.* He is recognized throughout the world for his work resulting in the present prominence of the study of sediments and sedimentary rocks.

Dr. K. C. Heald (left) received the AAPG Sidney Powers Memorial Award. Dr. W. H. Twenhofel (right) received SEPM Award in Recognition of Services.

the Canadian approach...

to the exploitation of its vast petroleum resources follows a familiar path in the history of other great proven regions. The search is keyed to geophysical activity, with approximately 22 percent of the world's crews operating in the Canadian provinces. In recognition of this tremendous growth an important step has been taken to coordinate activities under an increasing demand for GSI services in the Dominion of Canada. We proudly announce the formation of Geophysical Service International Corporation with C. M. Moore, Jr., as Vice President and Manager. Canadian operators will continue to receive the services of experienced resident personnel plus the benefits of GSI's complete research and development programs. Mr. Moore and his supervisory staff have made major contributions to the seismic techniques of this vast region. They are an important part of Canada's geophysical history. Their knowledge can be yours.

CHARLES M. MOORE, JR.
VICE PRESIDENT and MANAGER

GEOPHYSICAL SERVICE INTERNATIONAL
CORPORATION

706 NINTH AVENUE WEST, CALGARY, ALBERTA, CANADA

6000 LEMMON AVENUE, DALLAS 9, TEXAS

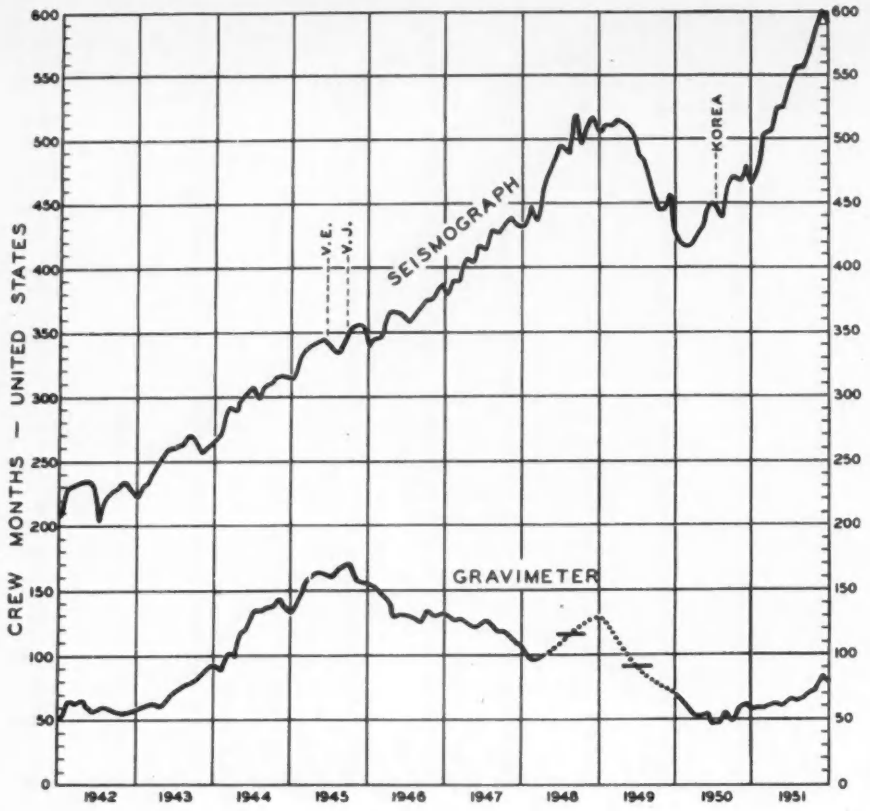


FIGURE 1. Monthly variation in seismograph and gravimeter crew-months in U. S.

FOR A NUMBER of years, the committee on geophysical activity of the Society of Exploration Geophysicists has made an annual report on geophysical activity throughout the world. It includes all types of geophysical methods and other industries in addition to oil. The following is that part of the report that pertains to the oil industry and shows the distribution of geophysical activity. Dr. Eckhardt has been chairman of this committee for several years. Other members of the committee are A. A. Brant, Herbert Hoover, Jr., and D. C. Skeels. This report was presented at the society's 1952 Annual meeting in Los Angeles, March 24.

Expansion of Geophysical Activity Unprecedented

By DR. E. A. ECKHARDT

Gulf Research & Development Company, Pittsburgh

UNPRECEDENTED is the word which most aptly describes the expansion of geophysical activity during 1951. The seismograph work done everywhere by the oil industry during the year required the full-time services of 791 crews, an increase of 134 crews or 20.4 percent over 1950. Gravity work was also increased during 1951, requiring the full time services of 123 crews, an increase of 13 or approximately 12.2 percent over 1950.

The number of crews operating in the U. S. is plotted on a month-by-month basis for both seismograph and gravity in Figure 1. The chart covers ten years and shows vividly that at no time during this period, and in fact during any other, did the number of seismograph parties rise so rapidly. The increase in gravity operations was less pronounced, but strongly upward. The chart shows the peak in November with 600 seismograph parties working in the U. S. The slight drop in December is of no significance. Such drops have occurred at the same season in practically every year and are of a seasonal character. If, during 1952, seismograph work continues at the 1951 year-end rate without further increase, the 1952 rate would exceed the average 1951 rate by approximately 10 percent. Actually it is to be anticipated that the increase will be moderately greater than this.

In accomplishing the increase which occurred last year, the geophysicists have accomplished something of a miracle. Their number is not capable of expansion at will. A geophysicist is the product of training and experience. The acquisition of both takes time. The number of technically trained men that became available from the colleges and universities last year was far short of the demand for them by all industry, and the shortage had its full effect in limiting additions to the geophysical forces. The registration of the students now in the schools makes it clear that in the face of rising demand, the supply of graduates in the sciences and engineering will be decreasing for several years to come. The availability of suitably trained and experienced men is bound

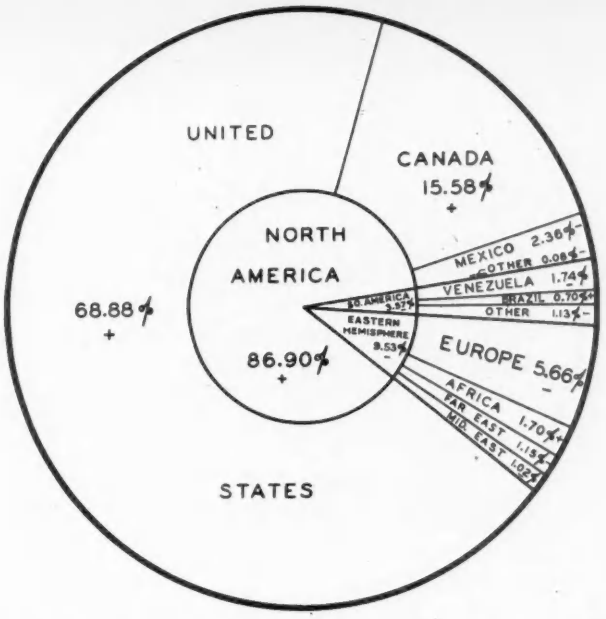


FIGURE 2. World distribution of seismograph operations in 1951.

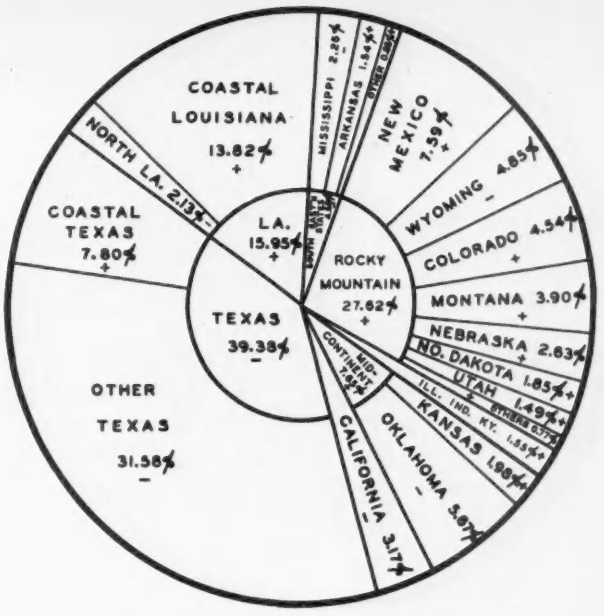


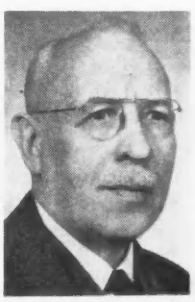
FIGURE 3. Distribution of 1951 seismograph operations in U. S.

to prove a major obstacle in the maintenance and further expansion of geophysical services.

It is generally conceded that geophysicists, on the average, are currently not doing the best possible job. This is not particularly their fault. There just are not enough of them to handle the volume of work.

While this is a familiar story to those directly engaged in wrestling with these problems, there is need that it be fully understood in other quarters. The intelligent expansion of geophysical services requires long range planning so that there is time to train men and give them the experience they will need to handle their jobs successfully. It is also important that each trained and experienced geophysicist be assigned in a manner to make the most effective use of his training and experience. There are not enough of them to go around; none of them should be wasted.

What has just been said about the manpower situation—when viewed against the background of our rearmament economy—deserves the most careful consideration of draft boards and military authorities. Unless they, as well as industry, recognize that the pool of technically trained men is well below the needs of the country and temper their drafts from the pool accordingly, the vital defense effort will suffer. In the national interest they, too, have the obligation to make the best possible use of their technical training and experience when such men are called to active military service. Unless this obligation is recognized and made an integral part of selection policy, an already critical situation could easily become disastrous. It is reassuring to note that reasonable progress in this direction is being made. At best, however, the state of affairs can only be described as spotty.



About the Author

DR. E. A. ECKHARDT, vice president of Gulf Research & Development Company, Pittsburgh, has been chairman of the Society of Exploration Geophysicists committee on geophysical activity for many years. He has been prominent in geophysical research for nearly half a century and is associated with many scientific organizations. He was the 1939-40 president of the SEG. A graduate of the University of Pennsylvania, he was granted his doctorate there in 1912, and served as an assistant professor of physics until 1917. After eight years as a physicist with the U. S. Bureau of Standards, he was made assistant chief of the research department of the Marland Oil Company in 1925. In 1929 he joined Gulf Research & Development as assistant director. He has lectured at the University of Pittsburgh in geology and geophysics. He was elected honorary member of SEG and cited at the annual meeting March 25th.

Much has been heard in recent years from Gobble-de-gook Center about equality of sacrifice or the equal distribution of the burden. It is an idea to which all of us can readily agree in principle. From some of its propounders one gets the impression that this is of first importance, a requirement to which all others must be subordinate. In truth, our greatest need is to win the struggle in which we are engaged. In sheer weight of manpower we are outnumbered, and we can hope to win only by superior use of our technology and technologists. Should we take technologists out of technology in order that equality of sacrifice may be more completely achieved? A complementary question is, "Should we permit anything that will make the winning of the struggle more uncertain, lengthen its duration and increase its cost?" An intelligent answer to the second question automatically provides an answer to the first. This answer may not be socially palatable, but we had better heed it and thereby improve the chances of saving our skins.

The question of geophysical personnel has been dealt with at such length because it is critical in deter-

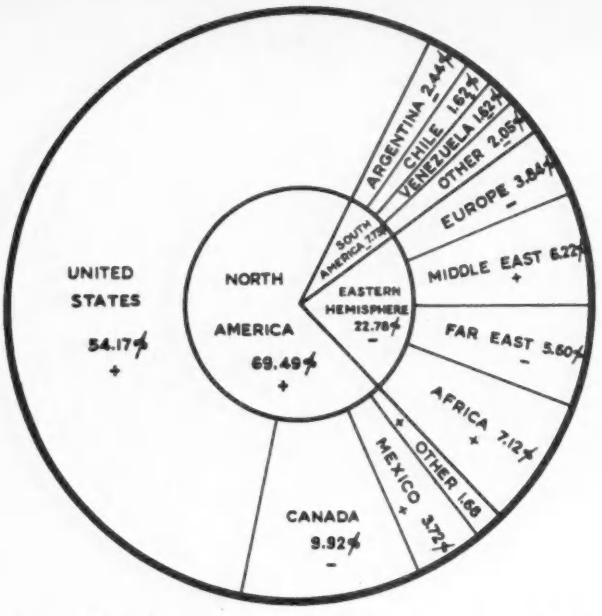


FIGURE 4. World distribution of gravimeter operations in 1951.

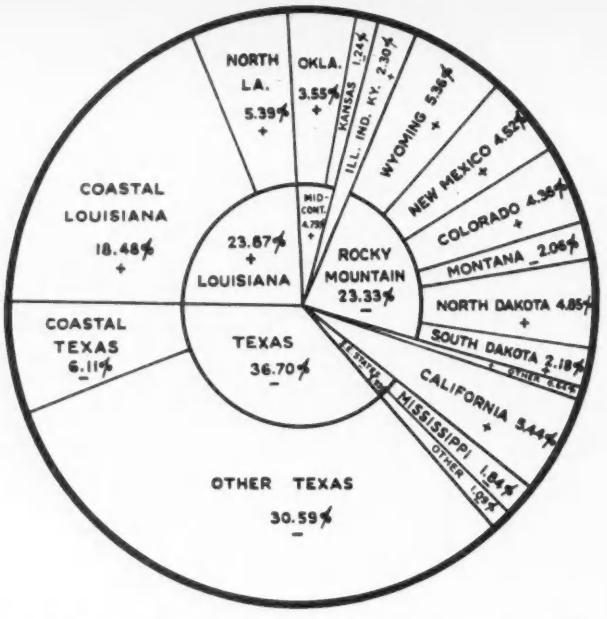


FIGURE 5. Distribution of 1951 gravimeter operations in U. S.

mining whether the need for geophysical service by the oil industry can be met in quality and quantity. We need more well-trained and experienced men for the operations in being. We will need still more if we are to expand the operations to meet the apparent demand.

Increase Breakdown

North America contributed the major component to the 20.4 percent increase in the world total of seismograph operations during 1951, the actual increase being 1519 crew-months for a 1951 total of 8248. For Canada the increase was 286 and for Mexico 90. Percentage-wise, the increase was greatest for Mexico (66.7 percent). Canada was next with an increase of 23.9 percent and that for the U. S. was 21.8 percent, or somewhat, above the average world increase. The trend away from the U. S. noted in the report for 1950 was clearly reversed last year. There was a less than average increase in the Eastern Hemisphere and a small decrease in volume in South America. The greatest percentage increase occurred in Africa, where activity more than doubled, and the greatest decrease, both numerically and in percent, took place in the Far East. This decrease is probably closely related to the unsettled political situation in that area.

The world distribution of seismograph operations in 1951 is shown in Figure 2. The pie is larger than for the preceding year but no major change in the size of the slices is apparent. Here and in the other charts the plus and minus signs indicate whether any given slice is larger or smaller compared to 1950.

In the U. S. the 1951 increase in seismograph operations amounted to 1172 crew-months. The Rocky Mountain states, Louisiana and Texas accounted for nearly all of it, and in the order named, the increases being 570, 303 and 241 crew-months and 46, 41, and 10 percent, respectively. The geographic distribution of seismograph operations in the U. S. in 1951 is shown in Figure 3. Texas retains its commanding lead, but by a reduced margin. As will be noted, Texas, the Rocky Mountain States and Louisiana accounted for approximately 83 percent of the seismograph work done in the U. S. last year. Among the Rocky Mountain states activity was most concentrated in New Mexico, Wyoming, Colorado and Montana, in that order. These states were the seat of more than 75 percent of the activity of this area.

Moderate Rise

Gravity operations the world over rose moderately during 1951 from a level of 1320 crew-months in 1950 to a total of 1481. As will be seen by reference to Figure 4, over half of such work last year was done in the U. S., which accounted for practically the entire world increase. The downward trend in U. S. operations for several years back was definitely reversed and at year end they were substantially at the highest level of the year. In Canada gravity work was done in practically the same volume as the year before and therefore its contribution to the world total declined. Considerable gravity work was done in Mexico last year, and it more than doubled its percentage share of the world effort. As was true also in seismograph operations, the greatest decline in gravity work was experienced in the Far East. Other shifts are apparent from the chart.

Texas In No. 1 Spot

The geographic distribution of gravity operations in the U. S. in 1951 is shown graphically in Figure 5. Out of a total of 802 crew-months reported for the country, Texas, with 36.7 percent, continued to hold the No. 1 spot. There was a relatively pronounced gain in Louisiana to a level about equal to that of the Rocky Mountain States. Between them these three areas accounted for over 84 percent of domestic gravity operations last year. The greatest gain occurred in Louisiana, more particularly in coastal Louisiana, and the greatest relative loss was recorded for Mississippi.

Again it is impossible to make a report on magnetometer operations on a basis comparable with the other activities. Data received do not differentiate between ground party and aeromagnetic crew-months, and since ground parties may use a variable number of instruments, the meaning

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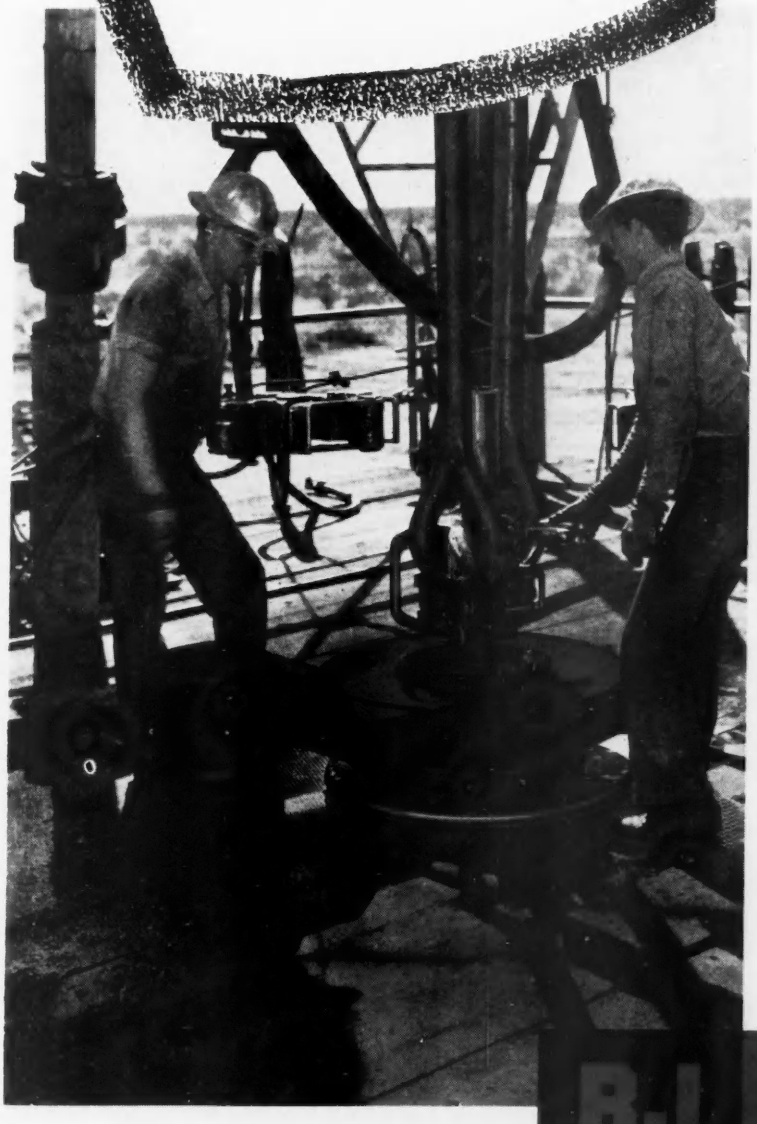

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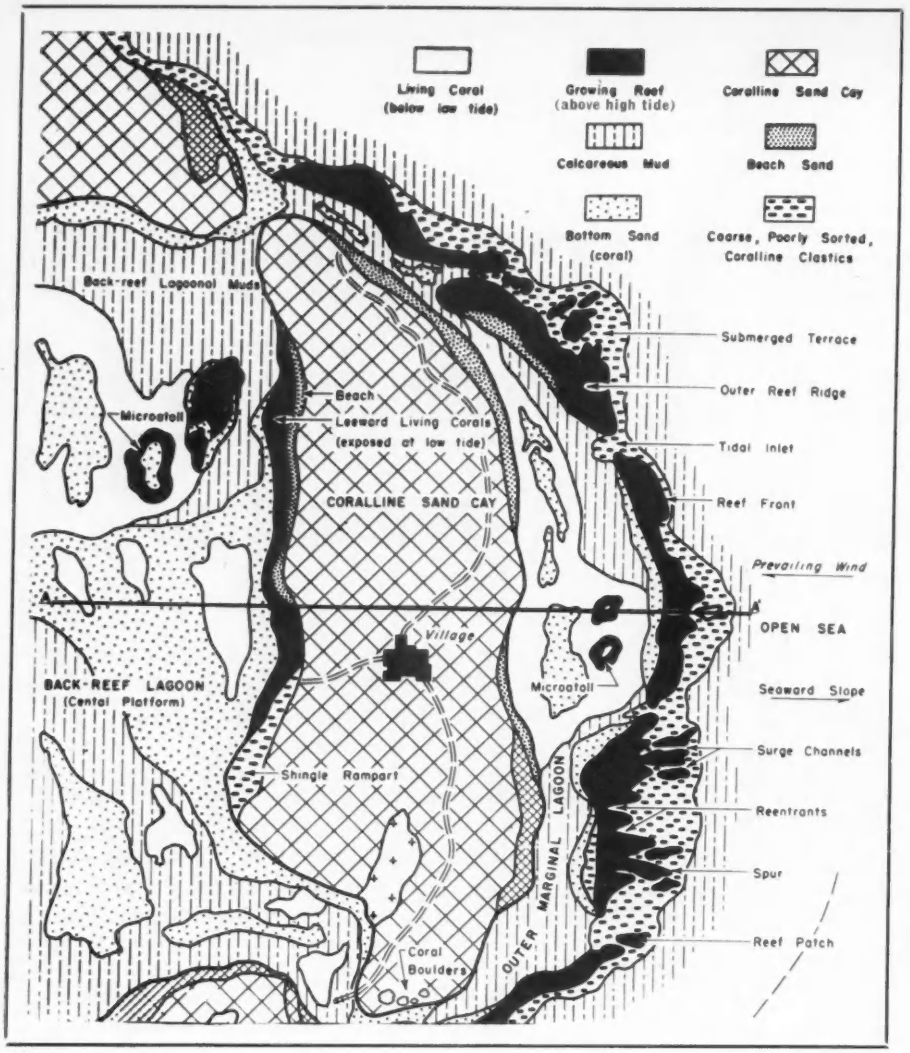

FIGURE 1. Diagrammatic drawing of a reef and its morphologic elements. Sedimentation is extremely variable and lateral changes of environments abrupt.

By DR. L. W. LEROY

Colorado School of Mines, Golden

INTERPRETATIONS of ancient reef complexes cannot be properly evaluated until more is known of modern reef mechanics. Studies of modern reefs and their related deposits should be systematized and field data carefully integrated. The author believes investigations of modern reefs must be carried on by experienced personnel and fully supported by management.

Recent Discoveries Show Need for

Concentrated Studies Of Modern Reefs

SINCE the discovery of Devonian reef production in the Leduc (1947) and contiguous fields of Alberta, Canada, more attention has been given the petroleum possibilities of ancient reef complexes in many other parts of North America and of the world. During recent years, search for reef production has been stimulated in the Williston Basin of North Dakota and in the Permian Basin of West Texas and eastern New Mexico. Evaluation of Silurian reefs and their trends is being carefully made in Illinois and Indiana. Similar investigations are being emphasized in the Middle East and in Russia.

Reef exploration is costly, time-consuming, and extremely complicated, particularly in areas where the reef complex is deeply buried by younger deposits. To minimize these factors, those responsible for discovering oil fields of this type should be adequately versed in reef anatomy. The must be cognizant of the sundry factors which control reefal development and distribution.

The evaluation of buried ancient reef complexes is difficult, particularly if data are insufficient or of poor quality. These evaluation problems include: (1) determining the type, size, outline, and trend of the complex; (2) establishing the relationship of reef cores to adjacent clastic sediments; (3) evaluating such variables as composition, texture, permeability, porosity, and thickness of the deposits; (4) integrating the complex into the regional structural and stratigraphic fabric; (5) outlining the distributional pattern of the oil, gas, and water within the complex; (6) deciphering the history of the origin, migration, and accumulation of the reefal fluids and gases; (7) planning and operating an efficient drilling and development program; and (8) selecting methods applicable for discovering adjacent productive fields.

Ancient as well as modern reef complexes must be analyzed in terms of space geometry, as their morphologic elements change gradationally and abruptly both vertically and horizontally. These changes influence drilling and completion procedures, calculation of reserves, future development programs, and leasing ap-

proaches. Thus, in order to obtain an improved background for evaluating and interpreting these ancient reef problems, more must be known of modern reef mechanics.

Data on Modern Reefs Needed

Within the last few years, Fairbridge,[1] Ladd,[2] Emery,[3] Taylor,[4] Tracey,[5] Kuenen,[6] and Umbgrove[7] have contributed greatly to our knowledge of the recent reefs of the South Pacific, Australia, and the East Indies. T. W. Vaughn must be given due credit for his classic investigations of West Indian reefs. These men (as well as J. H. Johnson,[8] J. E. Hoffmeister, J. Verwey, J. W. Wells, and others) have established only an introductory working foundation for future reef studies.

The morphology of modern reef complexes is complicated, and to integrate properly their numerous morphological elements, special attention must be given the following:

- Type and structure of the foundation upon which the reef complex rests.
- Development stages of the complex and factors controlling same.
- Surface and depth zonation of reef faunas and floras and zonal interrelationships.
- Erosional (chemical and mechanical) and depositional patterns within the complex.
- Influence of wind and water currents, surf action, turbidity, salinity, turbulency, and temperature on reefal development and/or retardation.
- Diagenetic processes in the reef core and in the flanking sediments.
- Major and minor internal and external structural grain of the complex.
- Effect of tectonic adjustments (local and regional) on reef-complex development.

An Approach to Modern Reef Studies

To initiate a systematic investigation of modern reef complexes, three requisites are mandatory: first, the personnel involved in the study must be adequately trained and experienced so as to permit integration and interpretation of field and laboratory results; second, there must be proper selection of reef-complex types for study; and third, management must have a clear understanding of the problem and must wholeheartedly support the project.

Reef-study programs should be supervised and controlled by one who possesses a broad background on ancient reefs and who also has experienced problems relating to reef-type production. This individual must work in close association with a biologist, zoologist, and paleontologist, all of whom would be largely responsible for mapping the faunal, floral, and ecological patterns of the reef complex. Systematized reefal studies cannot be accomplished in several weeks or even several months; therefore, management must agree to support a long-range program involving perhaps several years.

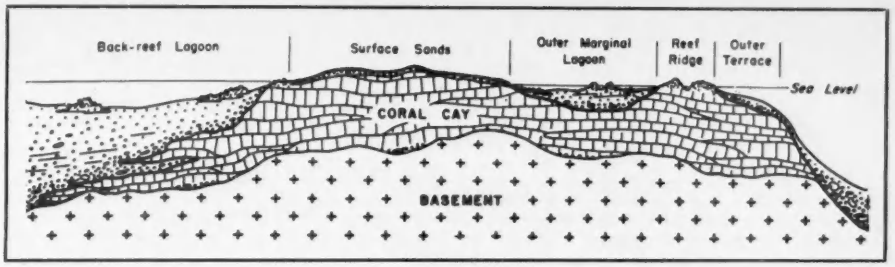

FIGURE 2. Cross-section (A-A') of the reef complex shown in Figure 1. Reef cores may develop on any type of rock foundation.

As previously mentioned, every reef complex possesses its own peculiarities; therefore, the study procedures and techniques must be adjusted accordingly. It is believed, however, that certain fundamental methods could be standardized and adapted to accommodate most investigations. The following procedures are suggested, although the sequence as herein presented need not be necessarily followed.

1. **Photographs:** After selecting the reef complex to be investigated, it is essential that the area be aerially photographed either in black and white or in color. Color photography is considered most favorable because of the surface details and contrasts observable. Enlarged prints of the area should be made for the purpose of ground (on-the-reef) control mapping. Colored transparencies should be taken of all the detail surface features as well as all the major morphologic elements (surge channels, grooves, solution benches, beach detritus, re-entrants, reef front, marginal channels, etc.). Care should be exercised in coordinating the ground photographs with a base-control map in order that the photographed features may be reviewed and reconsidered from the projection screen.

2. **Mapping the Reef Complex:** One of the most important phases in reefal studies involves the detail mapping of all the variables of the complex. Because of the innumerable reef elements and their intricate relationship, various maps may be compiled. These maps are essential before the total aspect of the complex can be deciphered accurately. The more basic map types should include the following:

a. **Topographic map:** The surface relief features of the reef complex should be carefully defined by reduced contour interval. This map permits improved understanding of possible past tectonic adjustments, character and extent of depositional and erosional patterns, and organic growth distribution. The map may be prepared directly from aerial photographs or from surface surveying procedures. Complementary to this map, there should also be one which illustrates the subsea topography of the complex. Advantage should be taken of any hydrographic maps available.

b. **Biofacies map:** A map portraying the distribution of reefal faunas and floras and their interrelationship is of utmost importance in any ancient or recent reef-complex study. Special attention should be given to the ecologic factors controlling the organic patterns. The three-dimensional aspects of these patterns may be obtained in part from diamond core information. Each species and species assemblage should be clearly classified, and such data as stage of development, population density, and ratio values (species, genera) should be recorded.

c. **Sediment map:** A reef complex involves many types of clastic deposits—coralline, algal, and foraminiferal sands; calcareous muds; and beach rubble, and intergradations of all three. The areal and subsea distribution of these deposits should be carefully mapped and sampled for detailed laboratory studies. The three-dimensional characteristics of the deposits should likewise be considered in order to obtain a more precise concept of depositional shifting through time.

Sediment maps should portray clastic-ratio, texture, composition, and particle-shape data.

d. **Panel diagrams:** Panel diagrams are extremely adaptable for portraying the three-dimensional variations and should be used

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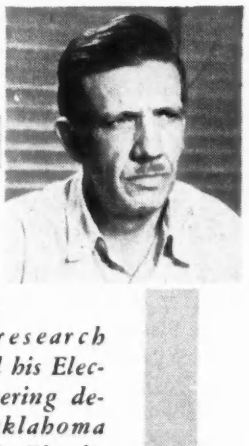

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Hold That Fossil!

Paleontology Aids Hunt For Hard-to-Find Oil

by

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HOW valuable is paleontology to the petroleum industry? Is paleontology an important exploration tool? How important is paleontology to the search for more reserves? These are questions asked daily by engineers, geologists, drillers, tool pushers, operators, managers and executives.

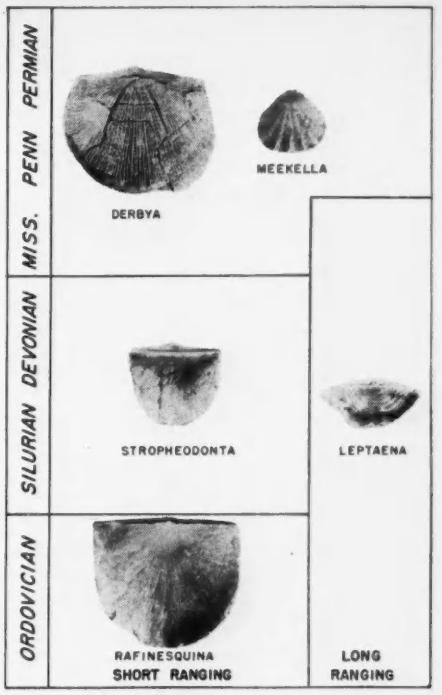
During the past 200 years, beginning with studies in western Europe, England, France and Germany, a vast array of information on the occurrences of fossils has been accumulated. From this storehouse of information, paleontologists have constructed a calendar tying together fossil occurrences with past geological events. The calendar is the timetable upon which geological formations, both surface and subsurface, all over the world are correlated. The timetable, unlike a train schedule, is not reduced, to hours and minutes. It relates each event to other events. It is like saying the U. S. declared its independence shortly after the Boston Tea Party during the reign of George III, instead of saying July 4, 1776.

Table Used Daily

The petroleum industry uses this timetable daily. Experience has shown that Miocene shales are "heaving shales" on the Gulf Coast; Arbuckle (Lower Ordovician) limestones are productive in central Kansas; Woodford (Upper Devonian) black shales are non-productive but give high radioactive readings on gamma ray logs in West Texas; and Woodbine (Cretaceous) sandstones are highly productive in the East Texas field. Terms like Miocene, Ordovician, Devonian and Cretaceous from the geological timetable are as familiar to the driller and toolpusher as to the research paleontologist. Some terms are well known even to the public. The beauty queen "Miss Permian Basin of 1951" unknowingly borrowed her name from one of the large divisions of the timetable.

Gulf Coast oil men know about the "Het" (short for Heterostegina) zone, the Marginulina zone, and the Cockfield zone, because these zones, named after abundant and characteristic fossils, are timetable markers used in making structural maps. Leases, royalties, minerals and drilling deals are bought and sold on the basis of whether the "Het" zone is running high or low. This in itself is reason enough to say—paleontology is valuable to the petroleum industry.

TODAY THE oil industry is turning more toward paleontology for additional aid in searching out the hard-to-find oil reservoirs. Paleontology is not confined to text books and laboratories. The authors explain simply and with practical illustrations the vital part that paleontology plays in looking for oil deposits. They make a plea to those concerned with sample catching and coring . . . get an accurate sample and don't throw fossils away for they may be the key to an oil field.



A family of brachiopods showing orderly succession through geological time. Paleontologists recognize that beds containing Derbya and Meekella always occur above those containing earlier members of family.

Law of Superposition

Geologists have long recognized that the younger beds of geological time have been deposited on top of older beds. They refer to this as the Law of Superposition. Likewise, paleontologists recognize that the most primitive organisms are recorded as fossils in the oldest beds and, through a sequence of orderly steps, fossils of greater and greater complexity are found in progressively younger beds. This idea is called the Orderly Succession of Fossils. It is the guiding light to the paleontologist in his attempt to unravel stratigraphy.

The Orderly Succession of Fossils may be broken in some places by a gap in the sequence of fossils. Paleontologists are quick to interpret this gap as a missing part of the earth's history. Ordinarily the missing part is represented by an unconformity. Detailed mapping and accurate interpretation of unconformities are of the utmost importance because many petroleum reservoirs are found associated with unconformities. Reservoirs are found in truncated weathered rocks immediately below unconformities and as lensing and irregular sand bodies in the basal detrital rocks immediately above unconformities. many of the critical clues to interpreting the complex geology along an unconformity are obtained from fossil interpretations.

The ability to recognize the marker

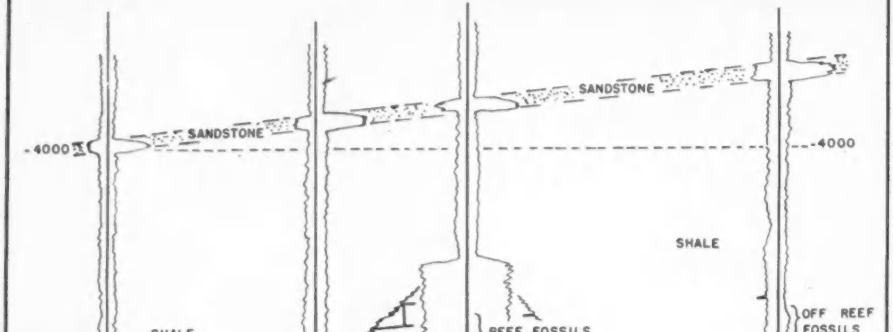


Diagram showing how marker fossils may carry through from shale to limestone and how knowledge of reef and off-reef fossils is guide to understanding the extent of limestone reefs. Limestone masses like this are common petroleum reservoirs in West Texas.

fossil is a most important factor in determining whether a zone is high or low. This is the paleontologist's job. He can recognize the marker fossil and by applying his backlog of experience he knows how widespread and how dependable this fossil may be as a guide in the geological strata. It is the paleontologist who really determines whether a well is high or low by identifying the "top" of the marker fossil zone. By calculating the elevation of the "top" and comparing it with the elevations of the "tops" in nearby wells, he has made the first step in local correlation and structural geology interpretation. Similarly the surface geologist recognizes fossil zones which he can correlate from hillside to hillside. The final surface geology map will depend on these correlations.

Local correlation of a "top" from one well to another may be expanded to a whole province, provided, let us say, the "Hets" are abundant and the zone continuous. Although "Hets" make a distinct and well known "top" only on the Gulf Coast, they are found less abundantly elsewhere in beds assigned to the upper third of the time scale. The "Het" zone may not occur in precisely the same time-table position in Venezuela, but its approximate position there along with other time restricted fossils will show that equivalent beds in Venezuela should also be assigned to the upper third of the time scale.

Correlation of zones, matching of fossils, and determining age relations between geological provinces are not easy. For example, certain wheat-grained-shaped fossils called Fusulinids are known in Pennsylvanian and Permian rocks of West Texas. They are accepted as excellent marker fossils in this province. Similar Fusulinids occur in Missouri, Kansas and Illinois. The groups of beds in these states are broadly correlated to the rocks in West Texas even though no single marker fossil can be carried through as a distinct and recognizable "top" between the two provinces.

Long ranging fosils exist through many feet of the geological column and short ranging fossils have restricted time-table limits. Both long and short ranging fossils are useful to the paleontologist for determining the geological age. The long ranging forms are broad time markers and the short ranging forms are excellent guides to distinct horizons. The key to the value of a particular fossil or suite of fossils is the backlog of information on fossil occurrences with which the paleontologist must be familiar.

One might ask how correlations from one well to another based on fossils are any better than correlations based on electric and radioactive logs. There is no physical, chemical or mystical method known that will tell us automatically the age interpretations from a mechanical log. Therefore, to place a rock unit in the time-table, the geologist must resort to in-

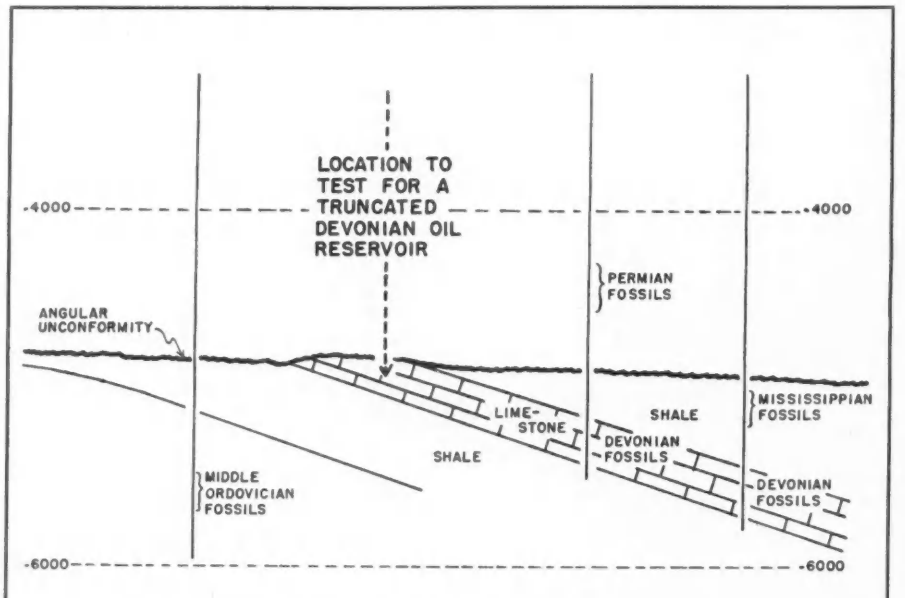


Diagram showing how age determination of fossils is used to locate a truncated Devonian limestone formation which may be a potential oil reservoir.

terpretations of the fossils. Once a fossil zone and its age are known, this zone may be recognized on the electric and radioactive log patterns. By means of patterns and occasional random fossil check the zone may be extended throughout a local area. Thus fossils and log patterns are useful as cooperative exploration tools.

One might also ask how correlations from one well to another based on fossils are superior to correlations based on lithologic (sample description) logs. Geologic ages are not determined wholly on lithology because the lithology of a timetable unit is variable. Composition, color and texture of a rock may give clues to its correlation, but the most reliable method is to combine the lithology and fossil interpretations. Thus fossils and sample logs are cooperative exploration tools.

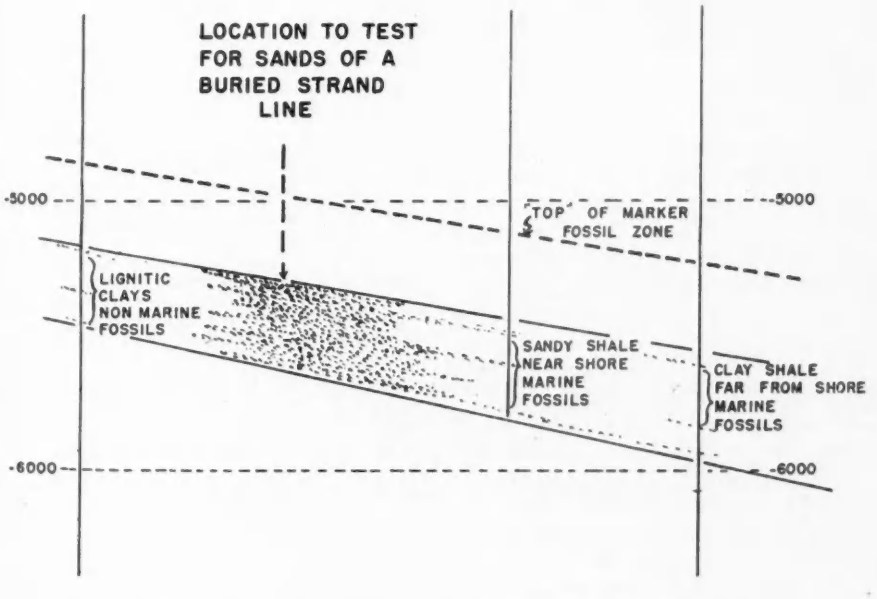
Certain geological sections like the black shales of the Black Shale Basin or the Clear Fork dolomitic limestones of West Texas are thick and monotonously uniform. Sample logs, electric logs and radioactive logs fail to give dependable local and regional correlating patterns within the monotonous section. The paleontologist may remove the nemesis and clear the mysteries of these thick monotonous sections by zoning these strata with fossils.

The search for oil is a search for porous and permeable zones that may be potential petroleum reservoirs. Geologists are aware that each geological province may have a sequence of porous and permeable zones in the stratigraphic column. The alert oil finder will immediately tie together the sequence of these zones with the sequence of fossils. He is then in the position to know whether the drill bit has penetrated all of the possible producing zones in a particular area. Wells have been abandoned only a few feet short of a petroleum reservoir because the operator lacked the paleontological data that would have told him that another porous and permeable zone was below the bit.

Geological correlations, local and regional, surface and subsurface, are and will continue to be the life blood of the petroleum exploration business. Paleontology plays a cooperative part in every correlation. Therefore, paleontology is an important exploration tool in the search for future reserves.

Fossils and Environments

Fossils tell us much about the environment in which the animal they represented once lived. Likewise, they give clues as to the nature of the environment in which the layers of sand, shale and limestone were deposited. Organisms, now and in the past, live within the restrictions of some particular environment. For example: sharks swim widely in the sea; corals dwell attached to the bottom of warm shallow clear seas; "Hets" (single-celled animals) crawl along the bottom of slightly muddy, warm,


LOCATION TO TEST FOR SANDS OF A BURIED STRAND LINE
-5000
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TOP OF MARKER FOSSIL ZONE
LIGNITIC CLAYS NON MARINE FOSSILS
SANDY SHALE NEAR SHORE MARINE FOSSILS
CLAY SHALE FAR FROM SHORE MARINE FOSSILS
-6000
-6000

Diagram showing how knowledge of the environment of fossils is used to locate strand line sands that may be potential oil reservoirs.

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Dr. James L. Wilson

DR. SAMUEL P. ELLISON, JR., professor of geology, was appointed chairman of the Department of Geology at The University of Texas in February, 1952. He received an A.B. degree in geology at the University of Kansas City, and A.M. and Ph.D. degrees in geology at the University of Missouri, where he taught for five years. He served as geologist for Stanolind Oil and Gas Company in Midland and Wichita Falls. Dr. Ellison joined the University of Texas staff in 1948, and teaches subsurface geology, micropaleontology and field geology.

Dr. John A. Wilson

DR. JOHN A. WILSON, associate professor of geology, has been on the staff at the University of Texas since 1946, specializing in vertebrate paleontology, historical geology and field geology. He received his A. B. and Ph.D. degrees in geology from the University of Michigan, and taught geology at the University of Idaho School of Mines for three years. He served in the U. S. Navy for three years during World War II.

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shallow seas; the horses graze on rolling prairies near fresh water rivers and lakes. "Hets" and horses do not live together, although both exist through the same span of geological time and both furnish important fossils for age determinations. By comparisons with modern organisms the paleontologist recognizes suites of fossils as land, shore or reef dwellers. The paleontologist pieces together the environment puzzle, bit by bit, so that he can locate the approximate positions of buried beach and strand lines or he can locate the trends of buried reefs. The porous and permeable zones of buried strand lines and buried limestone reefs are admitted first rate places to prospect for petroleum. Interpretation of the environment is extremely important when it is applied to the search for petroleum, because experience has shown that petroleum reservoirs are most closely associated with marine beds. Exploration objectives are to penetrate marine geological sections. Wildcatting will tend to be concentrated to the seaward side of buried beaches or strand lines rather than in the non-marine strata.

The best clues to whether strata are marine or non-marine, or whether the particular well is on the strand line or off the strand line, are from paleontological interpretations. For this reason paleontology has an important role in the search for future reserves.

Don't Throw Away Fossils

Roughnecks, drillers, toolpushers, engineers and well-sitting geologists should know that fossils come in all sizes, large and small. Some are so small that a microscope is required to see them. Microfossils are particularly important because they occur intact in cuttings. Their value in this respect is greater than megafossils, because the larger fossils are destroyed in cuttings by the crushing and breaking action of the drill bit. However, megafossils are common in cores and surface outcrops.

Plants, animals without backbones (invertebrates), and animals with backbone (vertebrates) have all supplied fossils, large and small, to the geological strata. None should be thrown away and none should be overlooked. To obtain the very best geological correlations and environment interpretations all fossils should be guided to paleontological experts for examination.

Geophysical Expansion

■ CONTINUED FROM PAGE 92

of ground crew-months is correspondingly indefinite. Since aeromagnetic and ground parties involve cost ratios of the order of 10 to 1 and data production in ratios of the order of 100 to 1, the problem of keeping track of even trends becomes somewhat complicated. To date there has been no success in providing good data for magnetometer operations. It is probably true, however, that much more magnetometer work was done by and for the oil industry last year in comparison to those immediately preceding.

For its geophysical operations in 1951 the oil industry probably spent not less than $300 million and possibly as much as $350 million. The bill for 1951 is greater in part because of substantially greater volume and in appreciable part because of greater unit costs.

Preliminary figures for 1951 indicate that U. S. production of crude oil for the year reached an all-time high of 2,242,698,000 barrels, exceeding the previous peak of 1948 by 10.6 percent. As a result of 1951 operations there was a net increase of 1,416,000,000 barrels in the estimated crude oil reserves of the country. The oil produced during the year was replaced by new discoveries and an increment of roughly 1.4 billion barrels was added to reserves. The discoveries for the year therefore were 3.659 billion barrels approximately. Before 1951 the peak year was 1937. The following comparisons for the two years are of interest, the units being millions of barrels:

	1937	1951
Total Discoveries	3,342	3,629
Production	2,042	2,213
Net Addition to Reserves	1,300	1,416

It is clear that 1951 was an all-time record year for the U. S. oil industry with respect to total discoveries, production, and net addition to reserves. In fact, it appears to have been a record year for the industry in all respects with the notable exception of profits. It is a record to which geophysicists have made important contributions and an achievement in which they can take great pride. We may also derive great satisfaction from the realization that this contribution has been made to a vital component of our national economy, and the anxiety of the nation can be somewhat relieved by the fact that the oil industry met its problems so successfully.

Reef Studies Needed

■ CONTINUED FROM PAGE 95

whenever possible in presenting reefal data.

e. **Other map types:** In addition to those maps mentional above, several other types could be prepared. These include: water analysis, temperature, turbidity, turbulency, current, and wind. All these data, independently or variously combined, play a major role in the final decipherment of reef-complex development.

3. **Diamond Coring:** A well organized diamond coring program is essential before the three-dimensional aspects of any reef complex can be evaluated properly. The number of holes cored will depend on the size of the area studied, depth of drilling, accessibility, amount of detail desired, and time allotted to complete the investigation. Coring in all cases should be continuous and extended to the base of the complex section. The cores should be carefully sampled, described, labeled, and filed. Samples should be submitted to the laboratory and analyzed in detail. Not only should coring be done in the carbonate reef core, but also in the adjacent clastic areas. Such data would undoubtedly add information relating to the possible source of hydrocarbons in ancient reef deposits. The results of core examination and evaluation must be considered as a critical phase in the study of any reef complex.

4. **Laboratory Procedures:** Laboratory investigations fostered by various specialists comprise a major section of the reef-study group. They are responsible for the many sample details not observable in the field. They must also be concerned with the following analyses—chemical, insoluble residue, textural, stain, porosity, permeability, micro- and macro-faunal, and trace element. Data obtained from these procedures must be closely coordinated with information secured in the field before final interpretations of the reef complex can be established.

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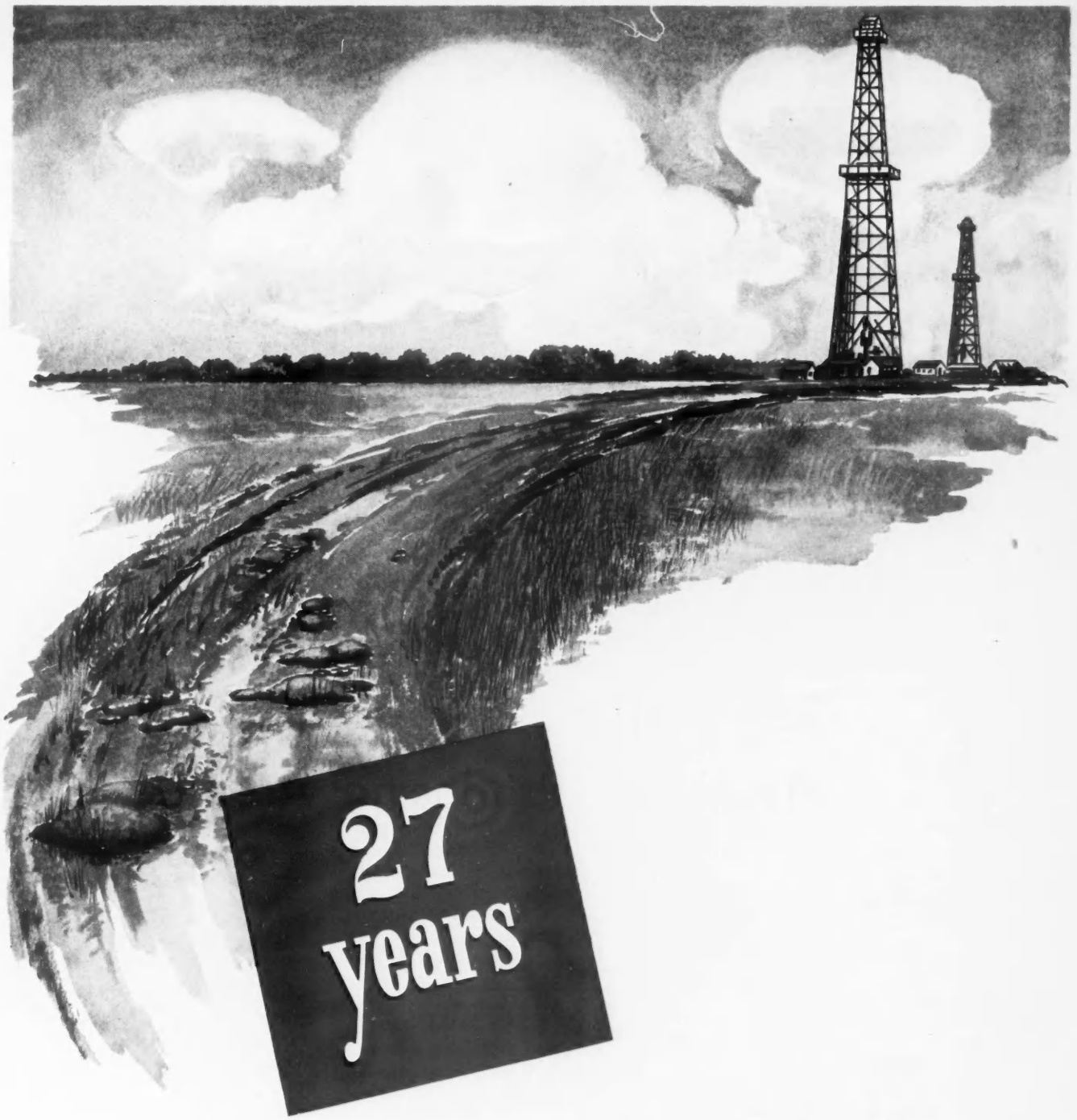

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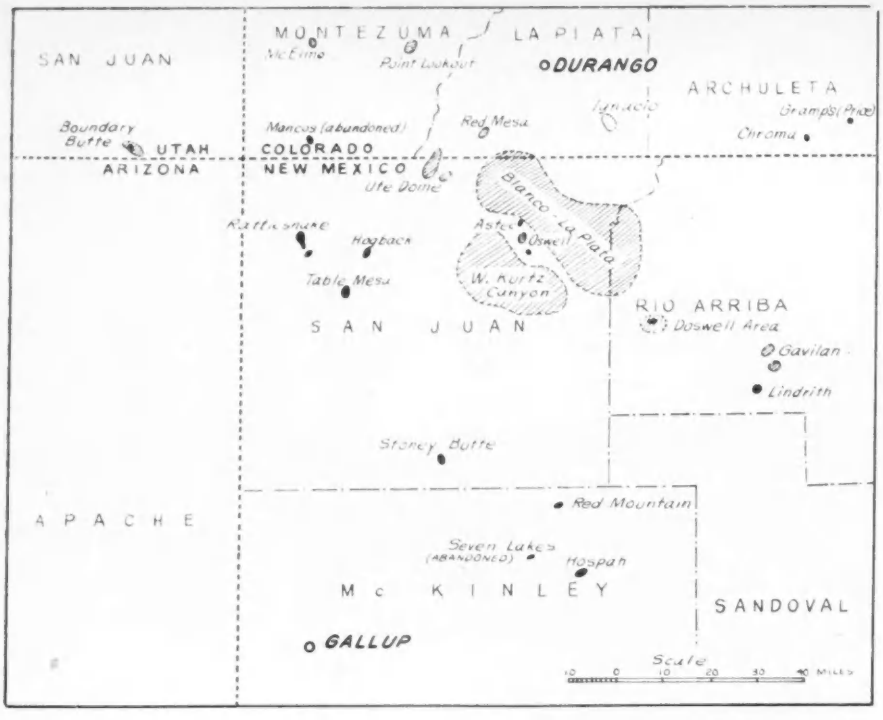


San Juan Basin at the junction of Colorado, New Mexico, Utah and Arizona. Solid areas show oil fields. Shaded areas are gas fields.

U. S. Geological Survey Map

San Juan Basin Becoming Major Gas-Producing Area

By GILBERT. M. WILSON

WORLD OIL Staff

THE SAN JUAN BASIN has taken its stand along side other major Rocky Mountain oil provinces. Discovery of sizeable gas fields in addition to high-gravity oil has added to the importance of the area and its value to the Western U. S. Here the development of the basin is traced and some of its current problems and practices discussed. And with 46 rotaries and approximately 15 cable tool rigs in the basin, the outlook for 1952 is promising.

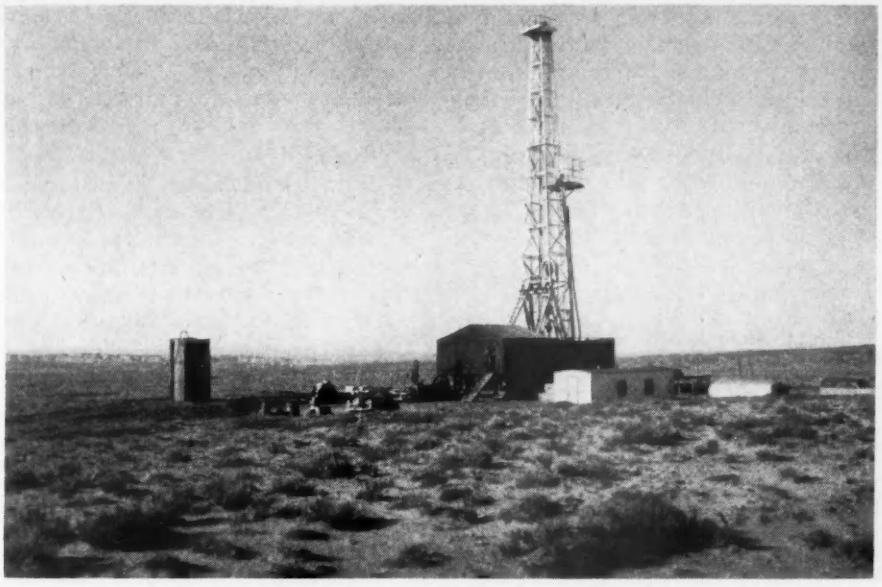
THE San Juan Basin rapidly is assuming the role of a major gas producing area. In addition, recent significant high-gravity oil finds appear to be pointing to the time when oil production, to date of relatively minor importance, will increase in volume.

At present, about 46 rotary rigs are in the basin, although only about 25 are running due to difficulties of operation and travel imposed by an unusually severe winter. In addition, 12 to 15 cable tool rigs, for the most part used for drilling-in gas wells, also are active. During 1951, about 267 wells were drilled in the basin, more than double the 117 drilled in 1950. Of the 1951 total, 46 were wildcats, more than twice the 21 wildcats drilled in 1950. Every indication points to another significant increase in activity in the basin during 1952.

San Juan Basin, called the "Four Corners Area" because it is located at the junction of Arizona, New Mexico, Colorado and Utah, covers an estimated 15,000 to 20,000 square miles and is roughly circular in shape.

The area has a semi-arid climate and a varied topography ranging from broad, open valleys near the center, to open desert and mesa country on the south and east, and extremely rugged country in the east and to some extent in the northern portions. Relief in the open portions of the basin ranges up to several hundred feet. In the eastern and northern rim of the basin, the relief is much greater, ranging up to several thousand feet. Sharp ridges, hogbacks and broad mesas separated by narrow, steep-walled canyons, characterize the rougher parts of the basin. It is in this area, through which few roads have been constructed, that a lion's share of the gas development currently is being carried on. It is this rough topography also, which has a great influence over the rate of development of the area and the cost of drilling and producing the wells.

Although oil and gas development in the basin dates back to 1911 when



Medium to lightweight rigs are used for drilling the 2000-foot Pictured Cliff wells in the Kutz area south and west of Bloomfield.

oil was discovered at 300 to 400 feet in the Seven Lakes area and the discovery of gas near Aztec in 1920, the region did not gain prominence until recent years. Today 15 or 16 oil discoveries and a dozen or more gas discoveries have been made, some fields producing from more than one zone.

Blanco Trend Key Area

Since World War II by far the greatest interest in the basin has centered on the so-called Blanco Trend, an irregularly outlined northwest-southeast trending gas producing area centering in the Aztec-Blanco region east of Farmington. Production occurs principally in the Pictured Cliffs and Mesaverde formations of Upper Cretaceous age. Originally consisting of several rather widely spaced producing fields, including such areas as Fulcher-Kutz, Kutz Canyon (Angel Peak), Largo and La Plata, the area now appears to be one, or possibly two, huge producing areas. Based on the acreage thought to be ultimately productive, the Blanco trend now is 40 to 50 miles long and at its widest point 30 to 35 miles across. The area, of course, may have non-productive or lean spots within it and, because no definite delineation as yet has been made on all its outer edges, it may be extended even further in some directions.

At present, the western portion of this gas area, including West Kutz Canyon and the Fulcher-Kutz areas, produces principally from the Pictured Cliffs section at depths averaging around 2000 feet. The Blanco area, to the east of the Pictured Cliffs production, produces generally from the Mesaverde formation at depths of around 5000 feet. However, recent drilling has shown some indication that the Pictured Cliffs production overlaps into the Blanco Mesaverde area. In addition, on the basis of a recent discovery of gas in the shallower Fruitland sand (lying immediately above the Pictured Cliffs) and recently-discovered gas production in the Dakota, indications point toward the La Plata area of southern Colorado as another important area whose size only future development can determine.

The Barker Creek field, a large anticlinal structure producing gas from both Dakota sandstone and the Paradox (Pennsylvanian), and next largest in size of the gas producing fields, currently is some three miles wide by seven miles long and extends over into Colorado for a distance of several miles.

Among the more important oil discoveries made during the past year was the discovery of flowing high gravity production in the Tocito sand at 6622-38 feet in the South Largo area of Rio Arriba County, approximately 42 miles southeast of Farmington. A great deal of interest has been generated as a result of the oil discovery in this region and much leasing activity has been going on since.

On the opposite side of the basin, approximately 13 miles south and east of Shiprock, Continental Oil Company, in making a deep test of the old Dakota sand producing Table Mesa field, discovered flowing 52-gravity oil in the Mississippian, along with a million and a half feet of non-inflammable gas (CO_2 and helium) from interval 7450-7761 feet. Initial production, after acid treatment, was about 140 barrels per day through choke. The find provides a significant clue as to the possibilities of deeper pay horizons in the Basin.

Drilling Practices

No definite pattern of drilling and completion practices can be defined for the entire San Juan Basin, particularly with so many areas, operators and the variety of pay zones involved.

All types of rigs are in use, from heavy rigs capable of drilling 8000 to 9000-foot Paradox wells at Barker Creek, to medium and light jackknife rigs employed in Mesaverde and Pictured Cliffs areas.

General practice is to drill a 7⅝-inch hole after setting 9⅝-inch protection casing string, cemented to the surface, at 100 to 150 feet. In Pictured Cliffs areas, the well may either be drilled to the top of the producing sand or through the sand. In either case, rotary tools are moved off and cable tools brought in to drill out the plug.

Mesaverde wells are completed somewhat differently. Following the setting of a string of 7, 6⅝ or 5½-inch casing at the top of the Mesaverde it is fast become a general practice to drill in with the use of gas as the circulating medium (See "Gas Replaces Drilling Mud in San Juan Basin Operations," WORLD OIL, August, 1951). Rotary tools are moved off and a light rig moved in in rigging up for gas circulation.

Drill pipe practice in the area usually calls for 3½-inch for shallower Pictured Cliffs wells and 4½-inch for Mesaverde wells, Dakota and deeper drilling. From four to five drill collars generally are carried in drilling Pictured Cliffs and from 8 to 16 on Mesaverde wells.

Generally speaking, no special muds are necessary for most of the drilling. In some cases clay base water muds have been used to the top of the pay. Some regions present a danger of blowouts when passing through the Farmington sand at 800 feet or the Fruitland sand at around 1800 feet, and conditioning with weighting material is recommended. Circulation problems have occurred from time to time but generally they can be solved.

On Pictured Cliffs wells, an aver-

age of from four to six days is required to rig up and drill to the top of the sand, set pipe and move off. Tailing in with cable tools, shooting, cleaning out and placing the well on production generally requires another three to five days. On Mesaverde wells, 20 to 25 days is required to drill and set pipe at the top of the pay. Using the gas circulation technique with a light rig, the remaining 800 feet of hole, in the pay zone, generally can be drilled in another 10 days, this time including the moving in, drilling, shooting, cleaning out, running tubing and completing the well. These drilling times, however, must be tempered with weather and road conditions for it is not uncommon to have a rig isolated or shutdown for several days due to washouts in roads or blocking with snow or mud.

Rotary Speeds Vary

Typical rotary speeds vary from 75 to 90 rpm, the higher speeds usually being used on Mesaverde wells. Usual weight on the bit may vary from 5000 to 6000 pounds on Pictured Cliffs wells, to as high as 18,000 to 20,000 pounds on the deeper Mesaverde wells. Frequency of fishing jobs or the types of fishing jobs encountered, is no more than might be found in other comparable areas.

As a general rule, only one mud pump is used for both circulating and mud mixing. Only one shale shaker commonly is used as is also the case with the blow-out preventer. Mud pits usually are excavated, although in some cases, pre-fabricated steel pits are employed. Natural gas and LPG fuels are the most commonly used for drilling. On the shallow Pictured Cliffs wells, where comparatively little time is spend on a location, it usually does not pay to attempt to pipe in natural gas, so LPG commonly is employed, even though it is a more expensive fuel. In the deeper Mesaverde or other proven areas where drilling is deeper, natural gas, if available generally is piped in from an adjacent well or gathering line. Drilling water is either pumped to the site from nearby water wells or from shallow pits dug in stream beds that may be near the location. Water is trucked however, for a number of wells not having water otherwise available.

Completion and production practices are relatively simple. Nearly all wells are shot with nitro, the size of the shot ranging from an average of around 250 quarts in Pictured Cliffs wells to as high as 800 quarts in Mesaverde wells. After the shot, the hole is cleaned out, using cable tools in Pictured Cliffs wells and, as indicated earlier, more generally with the gas circulation technique with rotary tools in the Mesaverde wells.

Open Flow Potentials

Open flow potentials of Mesaverde wells usually range from 3 to 4 million cubic feet per day. Deliverability ordinarily ranges from ¾ to one million feet at the 500 pounds pressure required at the pipe line. Pictured Cliffs wells have a lower open flow potential, averaging from ½ to ¾ million cubic feet. Deliverability of these wells usually is around ¼-million feet on entering the pipe line at 250 pounds. Higher flow rates are encountered in numerous wells in the basin, but these figures are what is considered an average of stabilized rates.

Barker Creek field produces the greatest volume of gas in the basin. Pressures are high, ranging at the present time from 2700 to 2800 pounds per square inch and having very high potentials. Casing pressures in the Pictured Cliffs area range from 450 to as high as 600 pounds and those in the Mesaverde, from 900 to 1100 pounds per square inch. Barker Creek gas contains very little gasoline, propane and butane. It is highly acid, however, and must be treated and dehydrated before it goes out into the line. Gas from the Kutz and Blanco areas is very sweet and can be delivered to the line without treating. Its gasoline and LPG content is relatively high, however, and it is processed at a natural gasoline plant.

Roads are Big Problem

One of the principal problems faced by operators in the area is the lack of suitable access roads. Paved U. S. Highway 555, following the San Juan and Animas rivers, traverses the northern part of the basin. New Mexico Highway 44, also paved, extends from Aztec to Albuquerque. Other roads, however, generally are of gravel or graded construction and, in most cases, operators must construct their own access roads in the more remote parts of the basin. In the rough country in the Blanco Trend, such road construction and location clearing costs often run as high as $5000 to as high as $10,000 for a single location. But some parts of the Pictured Cliffs producing area, south and west of Bloomfield, are situated on broad, relatively flat high plateau terrain and road costs are relatively small.

Principal machine shop facilities are available at Farmington, a rapidly growing town of between 3 and 4 thousand. Farmington and Aztec are the principal towns in the area and most crews and service personnel live in or near them. Few company-owned camps have been set up in the producing areas.

Spacing Pattern

Spacing pattern for Mesaverde wells is 320 acres, with wells being located in diagonal corners of each section. Pictured Cliffs wells are spaced one to 160 acres. Contract drilling footage rates range from $5.25 to $6 for Mesaverde wells, depending upon the type of contract made. Day rates with drill pipe average around $675 and $600 without drill pipe. Standby time with crew runs around $350 and without crew, $150. The operator generally furnishes mud, water and the location. One operator, where possible, furnishes fuel gas when it can be piped in from a nearby producing well or pipe line. Footage rates for the shallower Pictured Cliffs wells range from around $3.75 to $4.25 and, in most cases the contractor furnishes mud, water and fuel, depending upon the type of contract made.

With the market expanding steadily for natural gas from the San Juan Basin, there is every reason to believe that activity will continue to expand. Previous to the completion of El Paso Natural Gas Company's 24-inch line to California in the fall of 1951, the principal outlet for gas (outside of local consumption) had been Southern Union's 10 and 12-inch line to Albuquerque and vicinity. This line currently takes around 70 million feet. Completion of the El Paso line immediately created a market for another 150 million feet per day, with a peak demand as high as 170 million feet. This figure is due to increase as El Paso Natural Gas has filed application for an additional 122 million feet to be sent through its California line.

With clearing weather and drying out of roads this spring, it is anticipated that drilling activity, both development and wildcat, in the basin will increase substantially over even that recorded last year.

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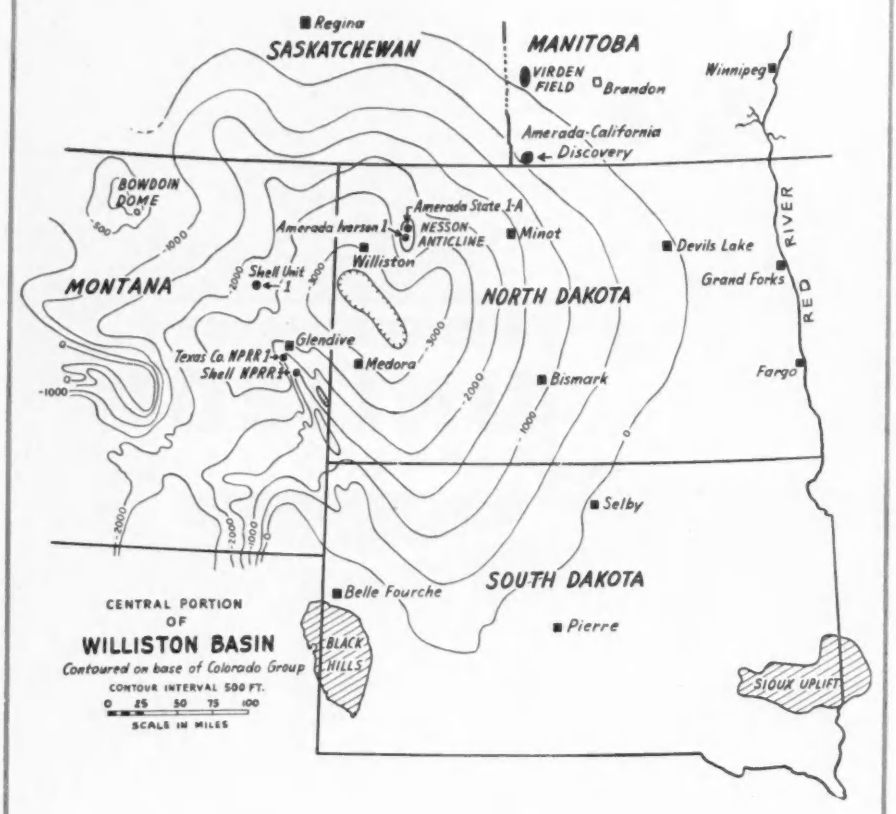

Producing Wells in Williston Basin.

NOT IN THE last decade has the United States experienced such enthusiasm over so many new potential oil provinces and the Williston Basin is getting a lion's share of attention. To the oil man making his first venture into this unknown territory, there are many varied and complex questions. What does it cost? How about roads and weather? What are the depths and formations? And many other questions. Here are some of the answers. They represent a cross section of experiences by those in the basin and should prove helpful to the uninitiated.

Williston Basin Pays Off

IT TAKES "blue chips" to operate in the Williston Basin, the nation's No. 1 hot spot, but for those who have made the venture, the rewards have justified the gamble. Mineral leases, bought for only ten cents per acre in 1947, are now going for as much as $170 per acre bonus and $1 annual rental (Devonian field area, Dawson County, Montana). It costs about $30,000 just to move a heavy duty rig from the Southwest to location, plus about $2000 per day to operate it. Total cost of the Amerada Petroleum Corporation discovery well in North Dakota was near the $1 million figure. The Devonian (in the discovery well) and the Mississippian have so far proven the best oil producing sections. Production in the first was found between 11,000 and 12,000 feet; the Mississippian, between 7000 and 9000 feet. To test a 8500-foot well costs approximately $175,000 and to complete it with tank battery runs the bill up to almost $325,000. Deep wells testing the Devonian cost from $400,000 to $500,000. To maintain one geophysical crew in the field for just one month costs about $25,000, and on the last count there were over 50 crews working in the basin, and more coming after the spring thaws.

It has been estimated that nearly $200 million has been spent so far in the search for oil in this great new oil province. In spite of the high costs, more than 30 million acres have been leased for oil and gas exploitation. The basin itself occupies about 100 million acres and measures 500 miles across the widest section. The

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sedimentary column varies in thickness from 2000 feet in Manitoba, Canada, to 12,000 feet plus in the basin's center. There are 17 potential oil-bearing formations throughout the basin, although not exposed in a single well column. The aerial extent of this tremendous geologic basin is even greater than the prolific Permian Basin of West Texas.

It is significant that production has been found at widely scattered points through the basin. Two fiields were found inside the basin limits in Manitoba on the Canadian side, some 250 miles north of the Amerada discovery. Shell Oil Company and The Texas Company completed producers in Montana opening up new horizons there, about 120 air miles from the Amerada discovery. The Nesson anticline in northwest North Dakota on which the discovery well was drilled and the Baker-Glendive anticline in eastern Montana have been the two principle structures on which drilling has been concentrated. Since Amerada proved first commercial production in the basin area, four other wells are flowing into tanks to prove three fields in Montana and one field in North Dakota (Table 1). Several wells are testing, assuring the basin of at least two additional fields.

12 Wells Drilling

A rundown of drilling operations as of March 7, 1952 revealed 12 wells drilling in Montana, 3 in South Dakota and 15 in North Dakota, with the greatest concentration in Montana. There have been 11 dry holes drilled in the basin since the discovery well in April, 1951.

The Williston Basin area is noted for its rigorous winters, with temperature extremes varying from 45 degrees below zero to 114 degrees above. At Bismark, N. D., in 1950, average temperature in January was 8.5° F.; in July the average temperature was 70.6° F. Average annual precipitation in North Dakota in 1950 was 16.41 inches. To drillers and operators of the U. S. Gulf Coast this is of little consequence.

Transportation Problem

Transportation is a problem. The Great Northern railroad passes through Williston, N. D. as does U. S. Route 2, the only paved highway running east and west between Chicago and Seattle and Tacoma, Wash. There are no paved roads north and south and operations must be conducted over average farm-to-market roads which are difficult to travel in winter because of snow drifts.

Most rigs currently operating in the Williston Basin were shipped north from the U. S. Gulf Coast. Rail hauls are cheaper than moving over the highways although, despite the lack of a good network of first class paved highways, even heavy rigs such as are operating in the basin, could be moved to location by trucks.

Contractors have experienced little trouble so far as load limits are concerned, in North Dakota and South Dakota, although they believe highway authorities will be stricter in enforcement following winter thaws.

In Montana enforcement of highway load limits are more strict. Truckers may not exceed 16,000 pounds weight axle load or 32,000 pounds in tandem if 40 feet apart.

Because of the nature of operations, contractors, at present, are operating on day-work basis with companies who have no rigs paying from $1200 to $1500 a day rig time. It is estimated that approximately 25 contractors are in the area and more expected this spring and summer. More rigs might have been attracted to the basin but for the fact that rigs are not readily available for transfer to this area.

To combat the cold weather rigs are completely "winterized." Derricks are completely enclosed, generally with corrugated sheet iron; mud pits are enclosed; steam boilers are part of rig equipment to furnish heat for all services as well as for personnel living in trailers at the well site.

Butane is the major fuel used in drilling and this is hauled from Billings, Mont. Some rigs are burning crude oil from the wells already producing.

Housing for personnel is critical throughout the area. Trailers are popular and some help is furnished by local farmers who have been induced to rent rooms.

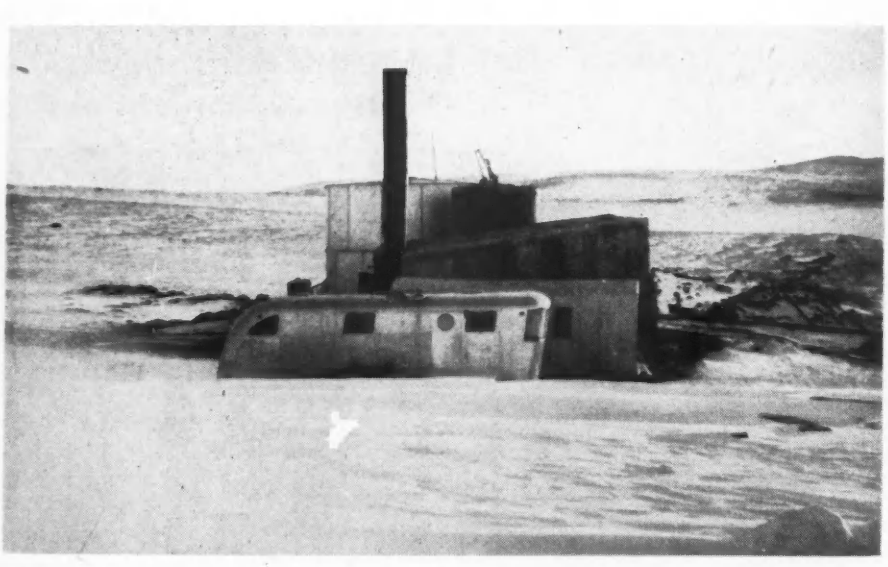
Water, so essential for all drilling and producing operations, poses no problem and there is plenty available from shallow strata ranging from 170 feet on down. Contractors drill their water wells, enclose their pits and have ample water for all purposes.

Digging is not too tough and no exceptional problems calling for special drilling fluids have been reported. However, after reaching the Madison limestone digging gets as tough as in other areas where the Mississippian spells hard work for the best rig and the sharpest rock bit.

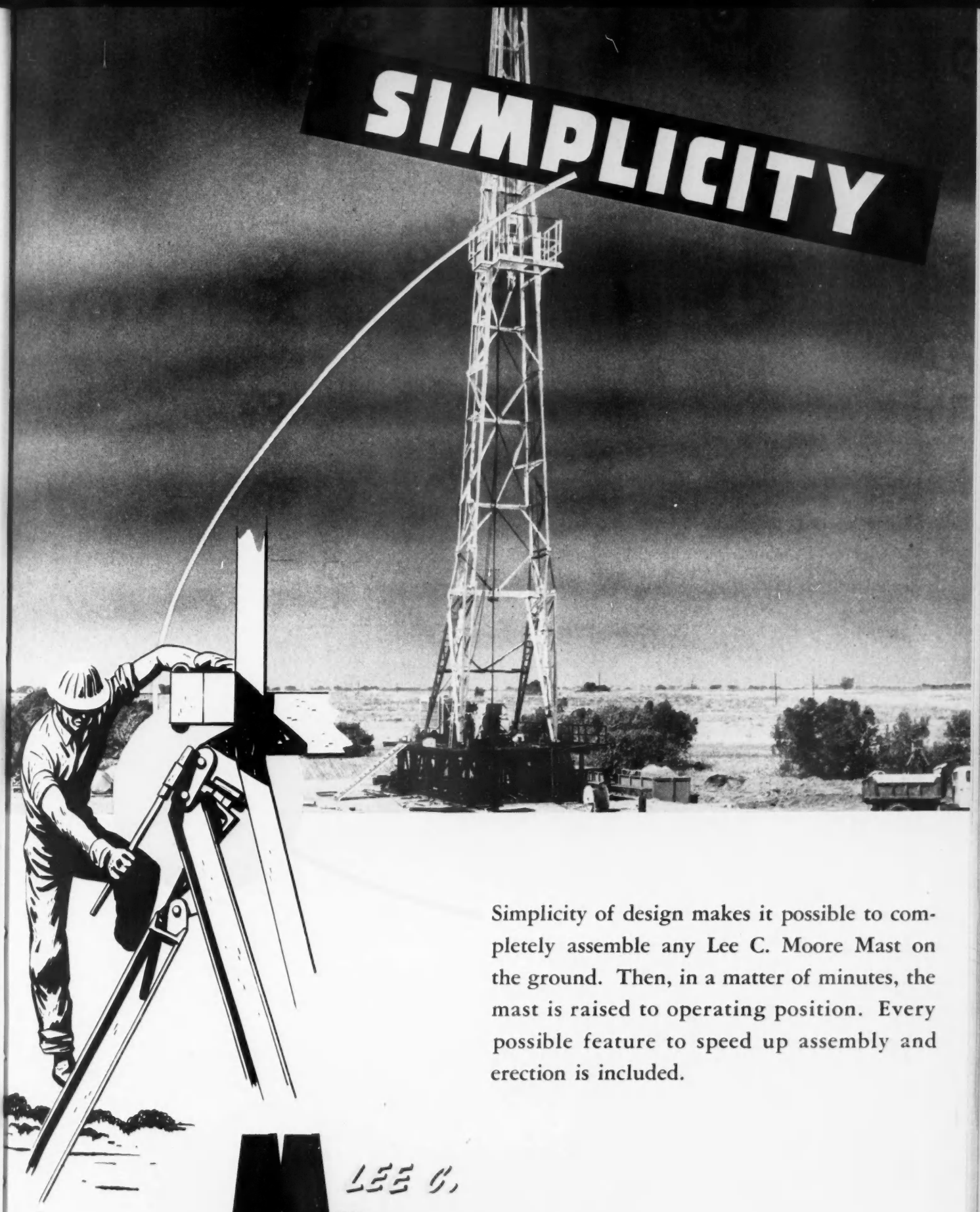
The usual casing program consists in setting about 350 feet of 13⅜-inch surface; 4000 feet of 9⅝-inch intermediate and 5½-inch and 7-inch oil string. Completions are through perforated pipe and all wells flow through various sized chokes.

Supply Centers

As in any new area, getting supplies to the field just discovered is one of the biggest problems for both producer and drilling contractor. Over 30 supply and service companies are represented in Williston, N. D., with a population of approximately 7000. Many operators have opened offices in Bismark, N. D. (population: 18,000) on the eastern edge of the basin. Minot, N. D. has been the center of much land and lease work. It's population is near 23,000 and it is the largest town in or near the basin proper. In Montana there are



Water and fuel tank, boiler and engineer's trailer "snowed in" at Shell Oil Company's J. K. Winters 1 in South Dakota. Courtesy: Shell Oil Company.



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Heavy-duty drilling rig at Shell Oil Company's J. K. Winters 1. Note the winterizing. Most working areas are totally enclosed. Courtesy: Shell Oil Co.

several growing supply and operating centers. Miles City with a population of 10,000 is about 175 miles from Williston, N. D. Glendive (population: 6000) is in the heart of the Montana activity and is growing rapidly.

Another bottleneck for the drilling contractor is lack of skilled labor in the area, making it necessary to import all drillers and crew men. There is little inclination on the part of the local people to work around the rigs. Mostly prosperous farmers or sons of prosperous farmers, they are content to watch the activities from the sidelines hoping to cash in on lease and royalty money. Millions of acres are under lease and considerable trading continues but no broker will venture a guess as to "average" leases prices. Before the discovery well leases were traded at 50 cents an acre and concentrations assembled in blocks ranging from 100,000 up to 500,000 acres. On the whole there has been cooperation between landowner and leaseman as the former recognize that many factors are to be considered in a lease trade and that a "hold out" in a block can prevent the drilling of a wildcat test and the possible opening of a new oil pool.

There are approximately 50 geophysical parties active in the basin with about 20 reported in North Dakota and 30 in the Montana sector. Additional crews are expected to be sent into the area as the weather moderates.

Service Pipe Line Company laid the first line of appreciable size (4 and 6-inch) to move crude from the Beaver Lodge field to Tioga, N. D. some 13 miles away. Capacity of the line is 18,000 barrels daily. Additional pipe line facilities are contemplated as soon as the pattern of development is outlined more clearly.

Refining facilities will soon be available in North Dakota when Standard Oil Company of Indiana completes its refinery at Williston, N. D. Only recently announced, the plant will have an initial capacity of 15,000 barrels throughout, and can be enlarged to double this volume.

PRODUCING OIL WELLS IN U. S. SECTION OF THE WILLISTON BASIN

Montana

Shell Oil Company's Unit 1 C SW NE 30-12n-57w, Wibaux County, pumped 346 barrels per day from 8910-8970 feet Devonian.
The Texas Company's NPRR 1, C NE NE 35-15-n-54e, Dawson County, flowed 254 barrels per day from 9031-9079 Lower Devonian.
Shell Oil Company's NPRR 1, NW NW 19-23n-50e, Dawson County, flowed 1656 barrels oil per day from 7183-7270 Charles lime, Mississippian.

North Dakota

Amerada's State 1-A, C NE SE 16-156n-95w, Williams County, flowed 521 barrels per day from 8490-8512 Madison lime, Mississippian.
Amerada's Clarence Iverson 1 C SW SW 6-155n-95w, Williams County, flowed 303 barrels per day from 10,490-10,530 Devonian. Discovery of new Beaver Lodge field. Was later worked over and completed from 8530-8540 feet in Madison lime, flowing 638 barrels per day.

CURRENT DRILLING ACTIVITY IN THE WILLISTON BASIN

Montana

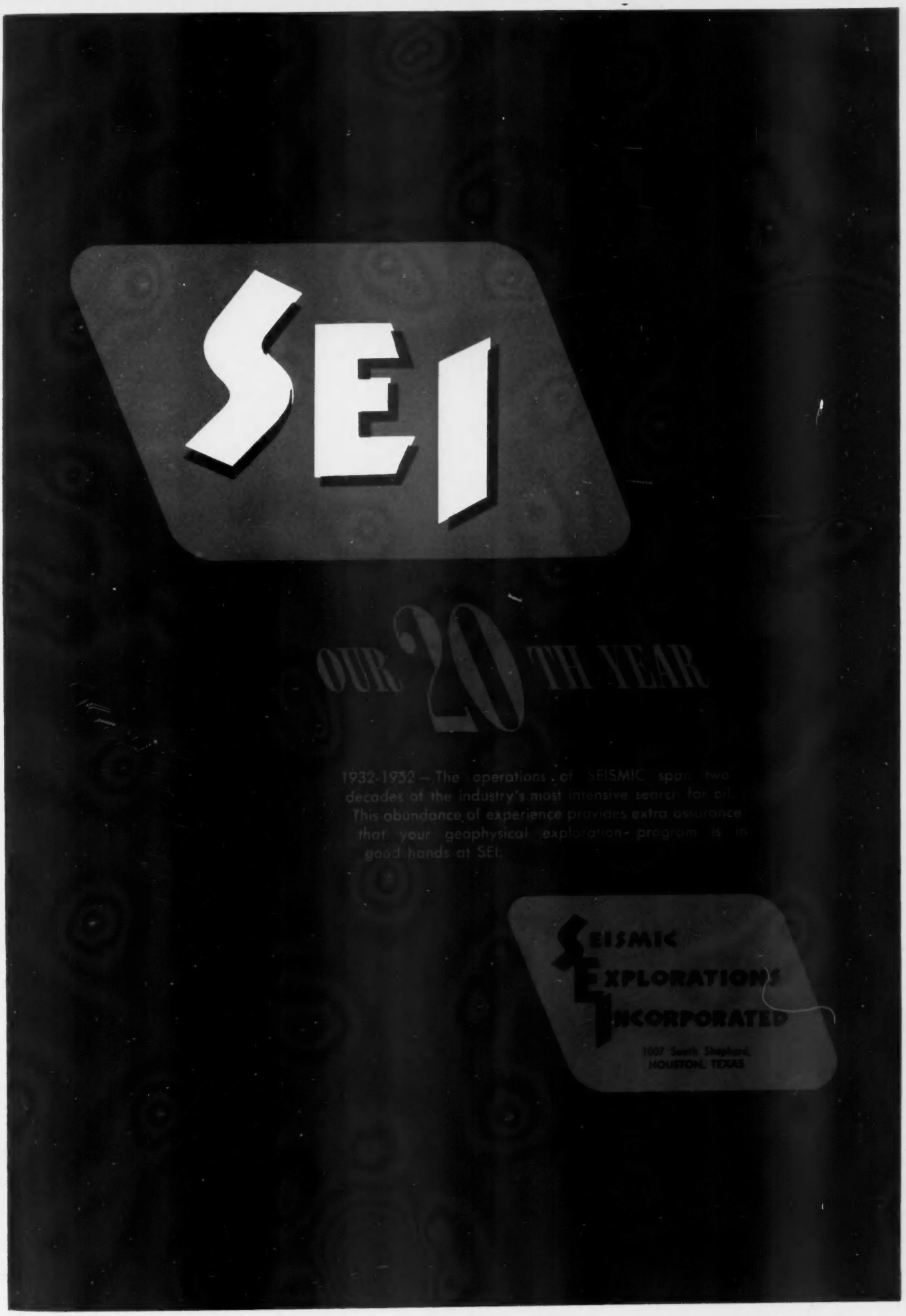
Shell's Government 34-26, C SW SE 26-15n-54e, Dawson County, Drlg TD 7463.
Texas Company's NPRR-NCT 2, C NW SW 21-16n-54e, Dawson County, Drlg TD 4694.
Shell's NPRR Co. 22-19, W/2 SE NW 19-23n-50e, Dawson County, rigging up rotary tools.
Shell's Unit 8-b-1, C NE SW 13-4n-6e, Fallon County, Drlg. TD 841
Mon-O-Co Oil Corporation's Baker 1, NW SW SE 2-7n-60e, Fallon County Drlg. TD 2012.
Shell's NPRR 22-25B, C SE NW 25-22n-48e, McCone County, Drlg. TD 7165.
Texas Company's Macioroski 1, C NW SW 23-16n-50e, Prairie County, Drlg. TD 8233.
C. H. Murphy's Unit 1, C SW NE 2-27n-51e, Roosevelt County, Testing TD 9163.
C. C. Thomas' Huber-Thomas 1, C SE NE 10-28n-51e, Roosevelt County, TD 630.
C. H. Murphy's Unit 2, C SW NE 18-28n-52e. Roosevelt County, Drilling TD 598.
Ajax Oil Corporation's McGowan 1, C SE SW 10-29n-50e, Roosevelt County, Drlg. TD 300.
Carter Oil Company's Unit C-294-1, C NW SW 18-29n-50e, Roosevelt County, Drlg. 6640.

North Dakota

Hunt Oil Co's Shoemaker 1, NE SW 3-157n-78w, McHenry County, D&A 7218, held for log tops.
Amerada's Ben Homer Risser 1, C SW SE 12-149n-96w, McKenzie County, Drlg. 13,280.
Amerada Petr. Co's K. Halvorson 1, NE SE 26-152n-96w, McKenzie County, Drlg. 9608.
Stanolind's Patented 1, SW SW SW 28-150-n-80w, McLean County, Drlg. 4920.
Wm. Herbert Hunt Tr. Est's Joe Wold 1, C SE SW 23-155n-81w, Ward County, Drlg. TD 5200.
M. B. Rudman & Amer. Viking & Tioga Petroleum's Math Iverson 1, C NE NW 18-155n-95w, Williams County, TD 12,000, to acidize.
Amerada's Marvin Iverson 1, C NE SE 1-155n-96w, Williams County, TD 8609.
Amerada's Almer Iverson 1, C NE NE 12-155n-96w, Williams County, digging pits.
Amerada's Alvin Iverson 1, C NE NE 14-155n-96w, Williams County, rigging up.
Amerada's Clif Nylander 1, C SW NE 15-156n-95w, Williams County, Drlg. 6550.
Amerada's Palmer H. Dilland 1, C SW NE 31-156n-95w, Williams County, TD 13,267, to drillstem test.
Amerada's Nels Odergaard 1, C NE NE 33-156n-95w, Williams County, TD 8678, swabbing.
Amerada's Knutson 1, C NE NE 36-156n-96w, Williams County, Coring 8597.
Champlin Refining Co's Elmer Tank 1, C NE NE 7-156n-96w, Williams County, Drlg. 5753.
Amerada's Henry O. Bakken 1, C SW NW 12-157n-95w, Williams County, Drlg. 13,572.

South Dakota

R. P. Harmon's W. Olson 1, SE NE NE 27-9n-3w, Butte County, TD 4000, shut down for winter.
Shell's J. K. Winter 1, C NW SW 11-22n-19e, Corson County, Drlg. 8010.
N. B. Hunt's State School & Indemnity 1, C SW NE 24-116n-73e, TD 2210, shut down for winter.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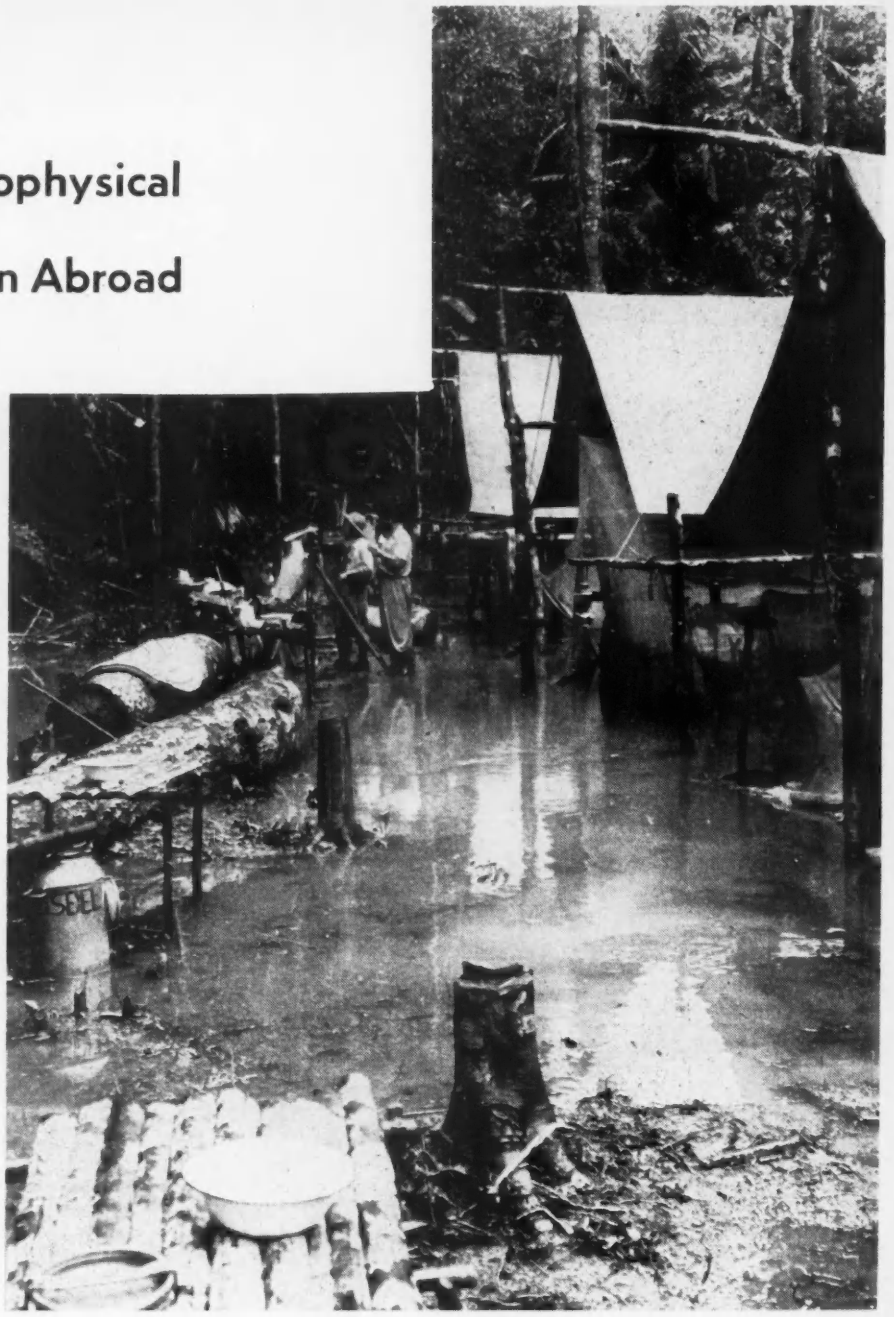
IT TAKES TIME

To Do Geophysical Exploration Abroad

SENDING GEOPHYSICAL crews outside the U. S. is a time-consuming task. Here's a vivid description—by a man who has first-hand knowledge of the problem—of some of the red tape that has to be unravelled before personnel and equipment can be transported abroad.

By R. S. SPRECKER

Traffic Manager,
Seismograph Service Corporation,
Tulsa.



Tropical jungles and swamps pose health and other problems for crew members of foreign geophysical explorations.

TIME! That's the big administrative problem in planning foreign geophysical exploration operations. The problem is further complicated when there's a deadline on the date the crews must be operating at foreign bases.

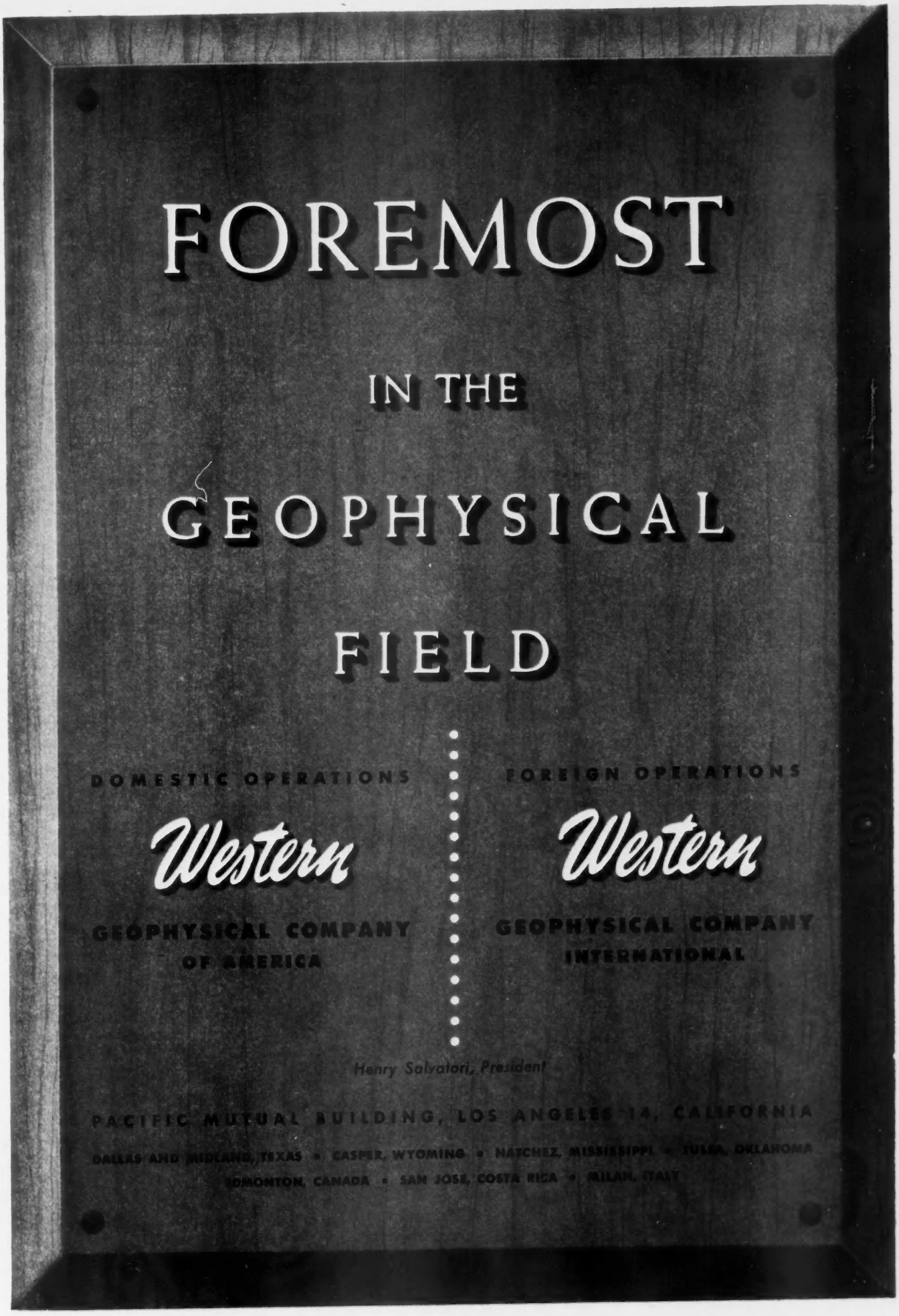
There are mountains of U. S. and foreign regulations on sending people and materiel abroad. It takes time to secure all the regulations. Time to study them. Time to secure the necessary licenses, permits, dollar acquisition authorizations, passports, visas, work permits and other documents controlling foreign operations.

World conditions in general—fluctuating economy and strife— have resulted in the amendment of many regulations and addition of others.

These conditions plus austerity programs, taxation and lower living standards in some cases make foreign assignments unattractive to many employes.

Employes considering foreign assignment must be presented the facts pertaining to livelihood in a foreign country in order that they may properly evaluate the benefits or hardships of such an undertaking. The time spent and the information gained concerning the job and the country to which the employe is going may mean the difference between his proving productive or non-productive.

The general procedure for the departure of an employe from the U. S. is fairly simple. Application must be made to the U. S. Department of State for a passport. These applications have to be presented personally by the employe to a clerk of a U. S. court. Two front view photos and an original birth certificate are required. Often the birth certificate submitted is not acceptable. The alternative is a State Department birth affidavit,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which must be signed by an immediate relative, verifying the date the employe was born. It usually takes approximately two weeks to secure a passport.

An application for permission to enter a foreign country must be submitted to that country's government. Most countries maintain consular offices at the chief U. S. ports of embarkation and entry permission is obtainable from these consular offices in the form of a visa endorsed in the passport. Some countries, including Venezuela, require all visa applications to be submitted directly to the appropriate governmental agency located in that country. This procedure may result in weeks of delay.

Visa applications must be accompanied by numerous front and side view photos, health certificates, preferably written on city or county health board stationery, character references and official fingerprint records from the police department of the city in which you reside, and usually a letter of financial responsibility from a bank or the employer. All countries have certain inoculation and vaccination requirements. These requirements must be determined and the health certificates must list the number of inoculations administered and the dates and show the results of vaccinations. The inoculations are generally given in series requiring several weeks to complete.

Other countries, including Mexico, require persons entering their countries for the purposes of employment to obtain work permits. These permits must be applied for in applications sent directly to the government agency concerned and the issuance of work permits may require many weeks.

Alien registration laws vary in different countries. Certain countries require registration at the time of entry while others permit forty-eight hours in which to register. A few countries require no registration. Travel permits must be obtained in some countries. The answers to all of these details must be furnished to employes departing for foreign assignments.

Firearms Banned

Customs laws and duty assessments covering household and personal effects present numerous problems. Mexico and other countries assess high duties upon unaccompanied personal baggage and household goods but permit their entrance, duty free, when accompanied by the person entering the country.

The provisions in all countries vary on the importation of personal cars and duty rates may double the value of the car in some countries. Firearms are banned in a great many foreign countries and employes are encouraged not to attempt to import guns of any type. Failure to obtain knowledge of the customs rules and regulations may prove costly.

The problems in connection with the exportation and importation of equipment and materiel are even more complicated and numerous than those concerning personnel. However, there are many more sources of information and assistance. There are the legitimate freight forwarders, steamship agents, airlines and similar companies in the U. S. and the customs brokers in the foreign countries who can furnish many of the answers.

Complicated Process

The U. S. government, through the issuance of restrictive regulations and orders affecting the exportation of materiel and equipment, has made exporting more complicated and difficult than the importation of the same items into a foreign country. Prior to the outbreak of hostilities in Korea, the Office of International Trade of the Department of Commerce was in the process of greatly reducing the number of commodities on the list of items requiring validated export licenses. But after inauguration of the rearmament program most materials came under rigid control again. In addition to increased export controls, shippers must now receive authorization to purchase and use the various materials which come under either the National Production Authority controlled materials plan or a material order. Export licensing and the priorities system are now so closely related that for many items you make a single application for both priorities assistance and an export license. Issuance of the export license is many times dependent upon the availability of the material under the priorities system. This dual processing is creating additional delays in obtaining export licenses.

Licenses for controlled materials—steel, copper and aluminum—may only be submitted during periods specified by the Office of International Trade. Should needs for such commodities develop after the expiration of these application periods there is another delay. This particularly affects the copper wire used in firing line and geophone cable, as well as drill pipe, shot-hole casing and cable line, all essential to daily operation of a geophysical exploration crew.

Many companies rely upon freight forwarders to obtain their export

A camp in Trinidad. Tents form convenient shelter and can be moved quickly from location to location.

licenses. The close relationship between export licenses and priorities assistance, the detailed information required for both, the maintenance of records, and the necessity for keeping abreast of the new orders and amendments issued by the National Production Authority, is definitely making this a full time function of the exporter. Furnishing the freight forwarder or any other person the necessary information required to obtain priorities assistance and an export license would appear to be a duplication of effort.

Adverse economical conditions experienced by most of the countries in the world today have forced their governments to drastically restrict the importations of many commodities. In most sterling bloc countries the ratio of imports to exports is governed by their dollar reserve. In practically all foreign countries, the importation of any commodities or items produced by that country is forbidden. Dollar acquisition authorizations must be obtained in some countries in order to obtain the dollars with which to pay for the imports, and in such instances, these authorizations may serve as the import permit. Other governments issue a specific import permit for various periods of time which must be obtained by direct application to the government, and unless you are in a position to present the application through a representative, these permits often require weeks to obtain.

Requirements Vary

Each foreign government has its own requirements concerning the form of documentation to be used in shipping materials within its borders. All require certain types of information concerning the commodities to be imported and every country insists upon the documents being made out in the particular language of the country to which the materials are being shipped. All documents covering the shipment, upon completion must be presented to the consul of the foreign government in the U. S. for endorsement. The freight forwarder renders invaluable service in preparing the documents, translating, classifying the commodities under the numbers assigned by the government of the country to which they are going and presenting the consular declarations for endorsement. The work

Crew members lay a temporary road in a jungle to transport a shot-hole drill to location.

done by the freight forwarder is extremely important as his classification of the commodities is the basis for customs appraisal at the destination and will determine the rate of duty which may or may not be assessed. His ability to correctly make out documents has a great deal of bearing upon the time consumed in clearing the shipment through foreign customs. The importance of the freight forwarder's work makes it essential to select only a forwarder of proven ability. The same is true in the selection of the customs broker responsible for clearing shipments in a foreign port. Native customs brokers often render more satisfactory service, due to their understanding and knowledge of the customs of the country and the trend of thinking of the citizens of the country.

There are no shortcuts in complying with the regulations governing a foreign operator, nor are there any economical short-cuts that may be employed in the last and all important crating, boxing or packing operation of material being prepared for export. Lightweight boxes or crates, metal strapped cardboard boxes or cartons, or burlap wrapping may prove tempting to the exporter desiring to economize through the use of lower cost materials or saving freight charges. But there is no substitute for strength, when it comes to protecting a shipment. To be convinced that inferior packing is a false economy one has but to visit a steamship dock warehouse where materials are accumulated for loading on a boat and note the huge heap of rubble that was once a shipment packed in light containers to economize.

Time Often Limited

All considered the primary operating problem is time. Time often so limited that the life of a contract may actually depend upon the proper utilization of time allotted for doing the job. Under such circumstances compliance with domestic and foreign government regulations, often appears to be an absolute impossibility. But failure to comply with regulations is far more expensive in both time and money. There are no bypasses around any of the procedures. Customs officials who handle your shipments are governed by the same rules and regulations as the shipper. He is not permitted to take any shortcuts.

True economy in foreign operations, measured both in time and money, will be determined by the extent to which each detail is followed, including the hard-to-read, small print footnotes so prevalent in all government regulations. The time spent in gaining a thorough working knowledge of the requirements of exporting and importing will prove to be your most reliable aid in expediting shipments of urgently needed materials.

About the Author

R. S. SPRECKER was born in Kansas City, Mo., and entered the oil business in 1924 with Johnson-Lodewick, Incorporated, in New Mexico as salesman. Later he became sales manager. In 1940 he joined The Ohio Oil Company at Billings, Mont., in the sales department and two years later entered the U. S. Army. He joined Seismograph Service Corporation in 1946 and is now traffic manager and priorities analyst.

Better Seismograph Reflection Records

By ROBERT B. RICE

Phillips Petroleum Company, Bartlesville, Okla.

PROBABLY no other field of seismic endeavor offers so much opportunity for the development of new concepts and techniques as the field of interpretation.

Though in some areas it was found impossible to obtain better records, it is still probable that the information wanted is buried beneath the hash on the record and can be separated from it by some process.

Herein lies the great chance for advancement in the field of interpretation. Once the travel times to the various reflection horizons have been obtained, present computing methods, with some desirable refinements, are adequate.

First to be discussed will be some of the aspects of present computing techniques that warrant brief attention, and then return will be made to the more difficult problem of separating wanted signals from noise. No consideration will be given here to the geological interpretation of seismic cross-sections and maps. This is a field which requires the best imagination and skill of men who are either well trained and experienced in both geophysics and geology or who are specialists in only one of these fields, but who posses the understanding and cooperative spirit required to work with those who are specialists in the other.

Picking Arrival Times

After obtaining a suitable recording of the wanted signals, the first task is to pick the various arrival times. This job is being performed quite efficiently by hundreds of experienced seismic computers every day. However, from time to time it is necessary to remember a few considerations which may be forgotten or ignored in the hurry to get the job done. A little more attention to these matters would improve the quality of work.

In picking arrival times of first-breaks, it should be remembered that the wavelet breaks away from the horizontal axis almost asymtotically. Thus, the time at which this break appears is a function of the amplitude of the wavelet—the larger the amplitude, the smaller the arrival time. (Figure 1). Hence, unless all first arrivals are adjusted to record at the same amplitude, the attempt to pick the onset of the first-arrival energy directly is likely to result in some error. A better method is to draw the tangents to the first legs or peaks and pick the times where these tangents cross the horizontals. Then, if desired, some reasonable fixed time can be subtracted from these times to obtain a closer approximation to the earliest arrival times of the first energy. The same remarks also apply to picking up-hole times.

Secondly, in picking reflections, it is important to note any change in shooting conditions, such as shooting depth, charge size, hole condition, formation in which the charge is fired, distribution of the charge, and tamping, for these quantities may affect reflection frequency and character. It is also important to note other factors such as a change in the depth of the reflection horizon, the effect of which has been discussed by Harris and Haskell[1]; a change in the tuning setting of the amplifiers, or a change in the way the geophones are planted, or in the type of surface on which they are planted.

In the third place, it should be remembered that in areas like the Gulf Coast where the differences in the depths of the various reflecting horizons may be smaller than the wave lengths of the reflections, the reflections as seen on the record may actually be a composite of a number of wavelets coming in at about the same time (Figure 2). Hence, the addition of subtraction of one or more of these component wavelets, caused by thin subsurface strata coming in or dying out, could cause a phase change

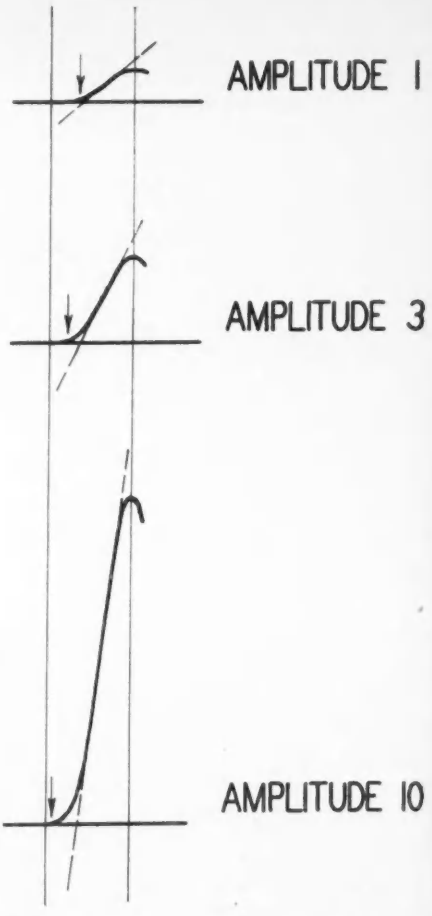

FIGURE 1. Picking arrival times with different amplitudes. Note different arrival times (arrows) obtained by picking point where wavelet appears to leave horizontal axis compared to identical times obtained by drawing tangent to first leg and substracting constant time interval.

TO OBTAIN better interpretation of seismic records, geophysicists should give special consideration to these factors: 1—Picking arrival time and reflections. 2—Computing time correlations. 3—Use of velocity curves; accuracy of seismic cross sections and maps is inherently limited by the accuracy of velocity curves used. 4—Computation of cross sections and maps. Such computations can be more accurate by making fuller use of increasing supply of velocity data. 5—Devices and mathematical processes for separation of reflections and noise.

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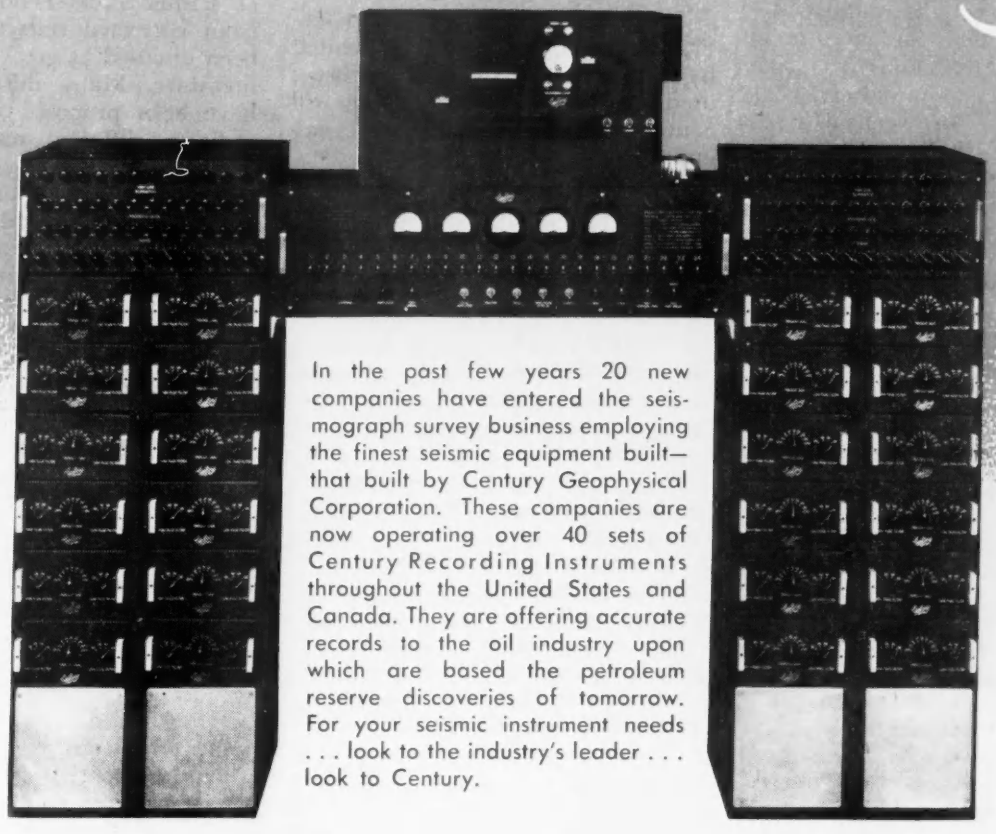

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About the Author

ROBERT B. RICE joined Phillips Petroleum Company as a reservoir engineer in the production department in 1941 after graduation from the College of Wooster, Wooster, Ohio, where he received his B.A. degree. In the fall he started teaching and doing graduate work in mathematics at Ohio State University and remained there until 1945 when he returned to Phillips as a process and design engineer in the gasoline department. In 1946 he went into the research and development department as master mathematician in the geophysics section of the research division. At present he is a group leader in the geophysics section.

or character change in the reflection complex on the record.

In the fourth place, it is important in the subsequent interpretation of seismic cross-sections and in picking and correlating reflections from one record to another to grade reflections and correlations. An excellent grading system has been developed by Gaby[2]. Many geophysicists use very slipshod methods of grading (which are too dependent on personal judgment) or none at all. The use of a scheme such as that proposed by Gaby would go far in putting the art of picking reflections on a more scientific basis. It would also serve as a valuable tool in detecing effects of the type mentioned above, which are many times overlooked unless records are scrutinized for detail.

Computing Time Corrections

The standard time corrections generally applied to reflection times are weathering corrections, elevation corrections, and corrections for spread length. (Figure 3.) Although computations of these corrections have been carried on for years and many different methods have been tried, there still appears to be some room for improvement. Practices which may produce sizable errors on occasion include the assumption of vertical travel paths through the weathered layer, the assumption that the horizontal refraction velocity below the weathered layer is the same as the instantaneous vertical velocity there, the use of weathering computation methods that produce weathering depths which are a function of the shot depth, the use of erroneous elevation correction velocities, and the use of spread correction methods for extra long spreads which do not allow for the fact that the average velocity over an oblique path of a reflection picked up by the end phones of an extra long spread may be considerably higher than the average velocity over a vertical path to the same reflecting horizon.

Using Velocity Curves

The accuracy of seismic cross-sections and maps is inherently limited by the accuracy of the velocity curves used. Fortunately, this situation will continue to improve with the accumulation of more velocity data. The accuracy of well velocity surveys is continually improving because the techniques of conducting these surveys are being improved and standardized. Knowledge of the quantitative effects of age and overburden on the vertical velocities of sedimentary beds has reached a rather complete state from an empirical point of view, chiefly because of the excellent correlation of a vast amount of statistical data by Faust[3]. The importance of regional velocity maps wherever enough data can be obtained to construct them is universally recognized.

In short, although lacking accurate velocity information in many areas today, if we continue to accumulate data at the present pace, and if high standards of accuracy are maintained in securing these data, results will continuously improve. We should not be content with an increased knowledge of vertical velocity gradients alone, however, but should also compile statistics and maps on refraction velocities at various depths and the ratio of refraction velocities to vertical velocities. The need for an increased knowledge of other types of wave motion also demands that data be compiled on the velocities or surface waves and methods be developed for the accurate measurement of shear velocities.

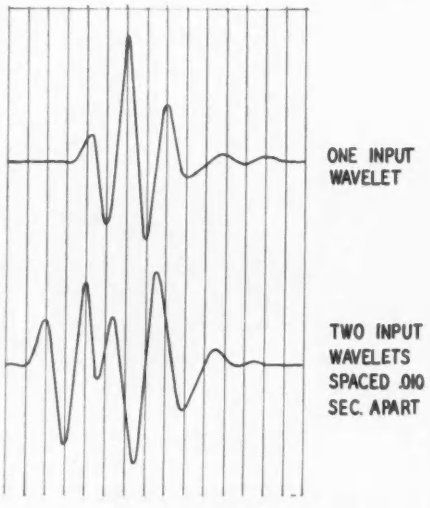

FIGURE 2. Response of standard seismograph to single 50 cycles per second reflection compared with two 50 c.p.s. reflections of same amplitude from closely spaced reflection horizons.

Computation of Cross-Sections and Maps

The subject of the computation of seismic cross-sections and maps from corrected reflection times has been discused at great lengths in the literature. Many different methods have been proposed which produce radically different results from the same raw data. Some of these methods conform more than others to our classical mathematical conception of the path followed by a seismic ray in traversing a sedimentary section of the earth and are therefore used because of their apparent rationality. Other apparently less rational methods are used by some because of their inherent simplicity or flexibility, or because they appear to produce a better resolution of the data.

It is the author's opinion that our present mathematical model will in time prove to be an oversimplified picture of the complex phenomenon of seismic wave propagation through the earth and that our best criterion today in the choice of a computing method is the result produced by that method. In any event, we should continue to study this problem; we should propose new theories and more new methods; and we should more fully analyze our results in all cases which are checked by drilling in order to evaluate methods.

Results can be improved by fuller use of the increasing supply of velocity data in the determination of the attitudes of the iso-velocity layers and the resulting forms of the ray paths. We should be careful not to make errors in the use of computational conveniences such as the datum plane and the two-dimensional cross-section, which is in reality a three-dimensional surface, and we should use our best imaginative powers in resolving complex data such as those obtained for combination refraction-reflection paths. Finally, in the search for stratigraphic traps, computation

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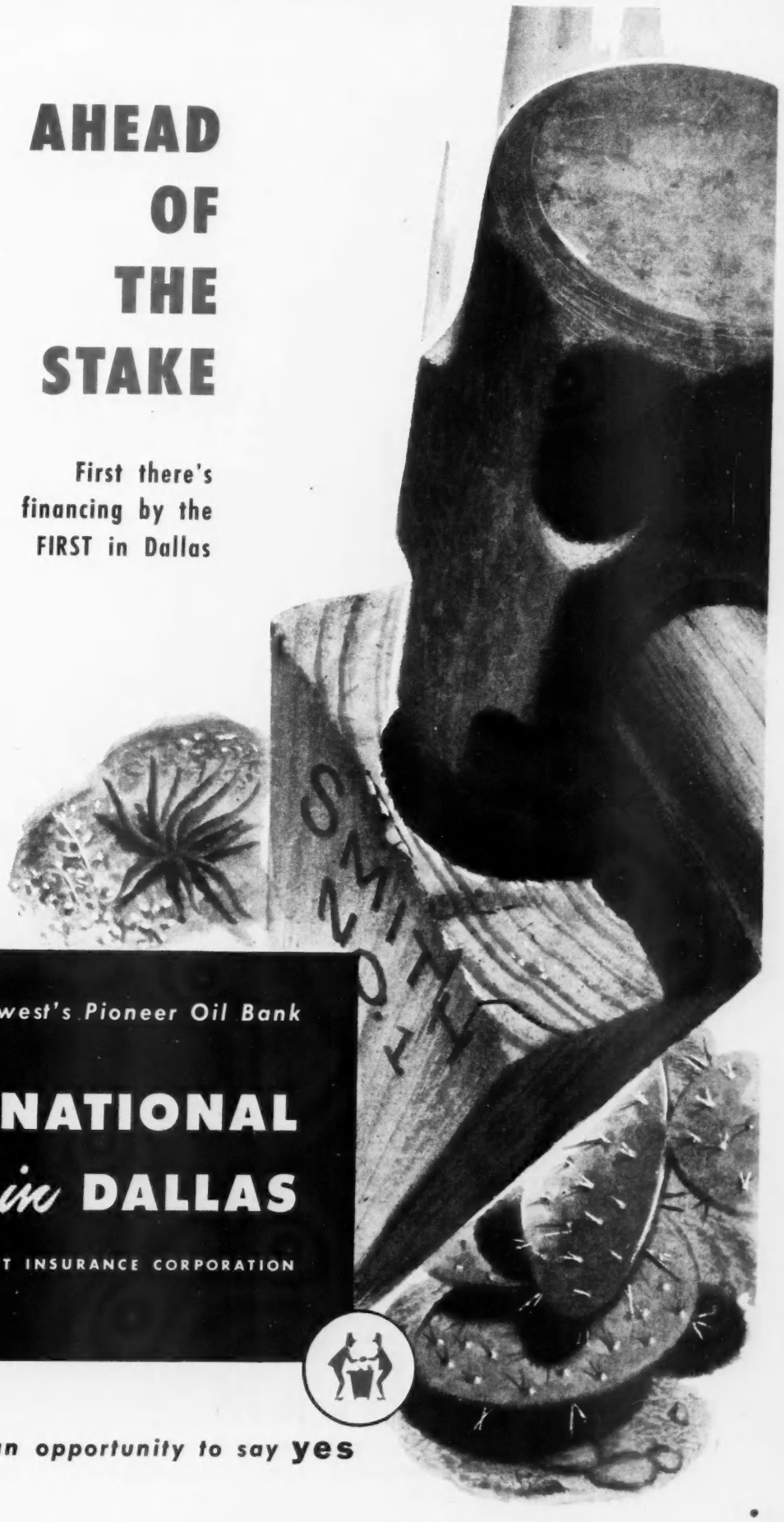

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of isopach maps should be greatly increased and a fuller investigation should be made of minor variations in reflection times which may have significance in regard to the subsurface.

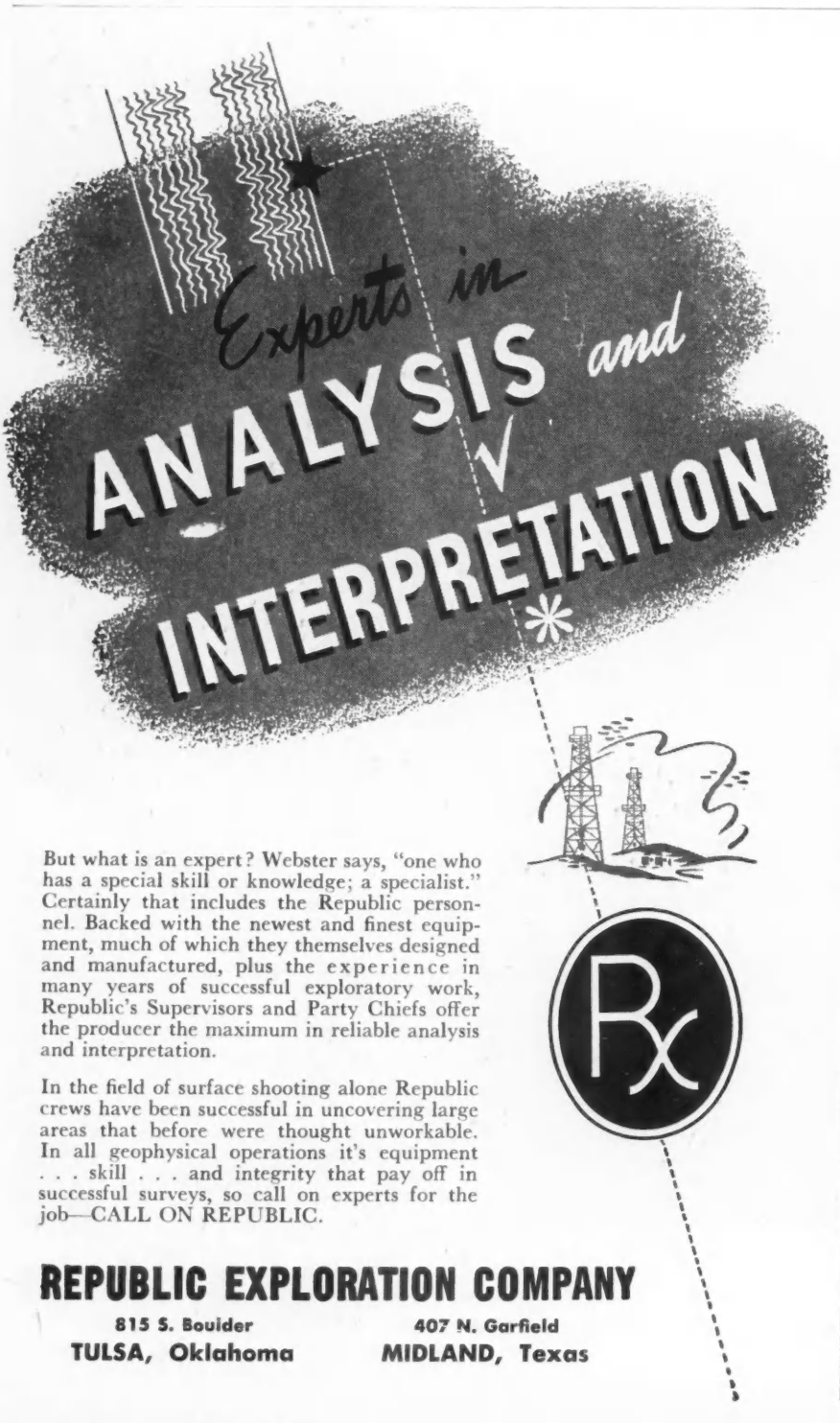
Reflections and Noise

We now return to the consideration of means for separating reflections from noise after the recording has already been made in the field. Even though a recording may be classed as an N.R., it still may be possible that the wanted signals are present on the record and can be separated from the noise or other signals which cause them to be incapable of being resolved by the eye.

There is, of course, one well-known example of such an interpretation aid already in existence, namely, the so-called Sonograph developed by Rieber.[4] This instrument, which was actually used in field operations in California and along the Gulf Coast from 1934 to 1938, was devised to analyze poor records which are the result of too many interfering reflections coming in at the same time from various types of structural anomalies such as synclines and fault zones. The resolution of the various reflections was accomplished by recording the seismograph traces as reproducible sound tracks and combining them in various phase relationships to build up the amplitudes of those waves coming in from a single direction. The development of a highly-improved form of the Sonograph, called "Geovision," in which the results were to be displayed in the form of a cross-section on a cathode-ray screen, was undertaken after the war by Rieber with the backing of several companies, but the death of Rieber in 1948 has greatly hampered the development of this new instrument.

No doubt other companies are at work on other devices for improving not only the resolution of multi directional reflections arriving at the same time, but also the separation of reflections from high level noise. The problem is a special type of communications problem, just as that involved in the separation of intelligible messages from noise in telephone or telegraph communication. Fortunately, a great deal of work has been done in the past few years by such mathematical wizards as Wiener[5] and Shannon[6] in the development of a mathematical theory of communication. The seismograph problem is different from the ones solved by these men, but their methods, though they are extremely complex mathematically, can serve as a guide for our work. It is difficult to say how effective such methods can be in the solution of the seismograph noise problem, for as yet there is very little knowledge of the exact nature of the problem and little experience in applying such methods. It should be possible, however, with the great progress now being made in the use of numerical methods and computing machines, to perform various complex mathematical operations on the record quite easily.

The starting point of such a program should be the acquisition of a great deal of fundamental knowledge about the nature of the noise, what its components are, and how they are generated. There is the possibility that the problem could be solved entirely from a statistical point of view by investigating the noise on a pure-



But what is an expert? Webster says, "one who has a special skill or knowledge; a specialist." Certainly that includes the Republic personnel. Backed with the newest and finest equipment, much of which they themselves designed and manufactured, plus the experience in many years of successful exploratory work, Republic's Supervisors and Party Chiefs offer the producer the maximum in reliable analysis and interpretation.

In the field of surface shooting alone Republic crews have been successful in uncovering large areas that before were thought unworkable. In all geophysical operations it's equipment . . . skill . . . and integrity that pay off in successful surveys, so call on experts for the job—CALL ON REPUBLIC.

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ly empirical basis, and this possibility should be investigated; but since the noise is many times no more random than the reflections to be separated from it, this approach seems to be the more difficult. On the other hand, if we will follow up the excellent theoretical work already done by men in our own profession such as C. H. Dix, Norman Ricker, C. Y. Fu, Alfred Wolf, Morris Muskat and others on the mathematical anlysis of the phenomena associated with wave propagation in the earth, in order to gain at least a qualitative picture of what types of phenomena to expect; and if we will pursue the problem of how to experimentally detect these phenomena, then we can use this knowledge in working with records to determine how the unwanted signals can be separated from the wanted ones. The problem is very complex and will undoubtedly take the expenditure of a great deal of time and money to solve, but we should be able to make some substantial progress in the not too distant future.

If the present demand for the discovery of more and more new oil reserves continues, (and there is every reason to believe that it will) and barring the discovery of some new superior method of locating oil-bearing structures which might replace the reflection seismograph method, it appears that we will have the economic incentive to spend a great deal of effort and money on these problems. The author has attempted to convey the impression that we have come a long way, for indeed we have: but we have only scratched the surface. We have reached the steep part of the climb which we have known for some time was inevitable, but we are far from being in the dark on how to proceed. If we will keep our eyes on the goals and use our best scientific talents, there is every reason to believe that we can make the reflection seismograph a much more effective exploration tool than it is today.

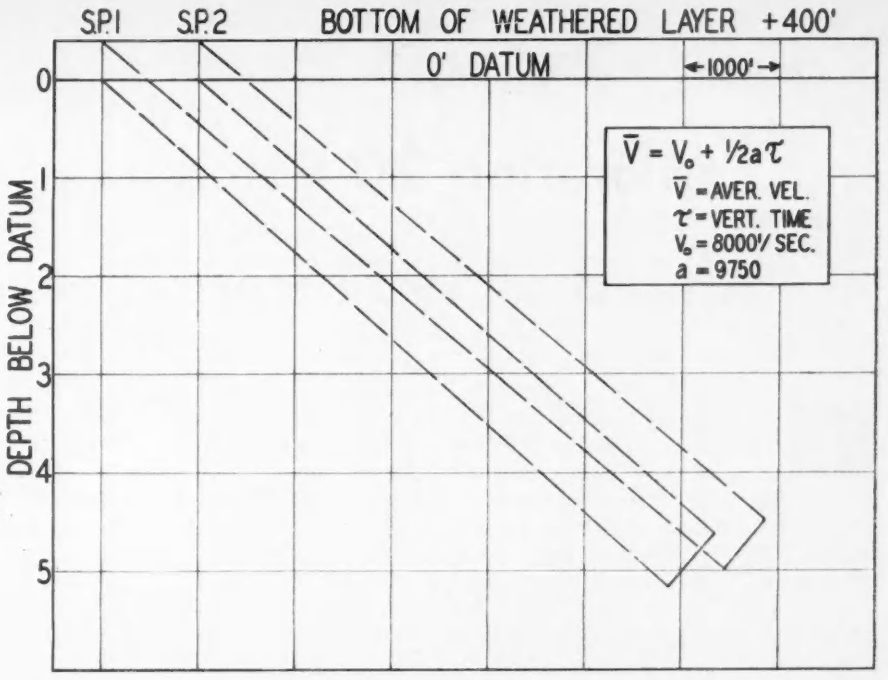

FIGURE 3. Effect of correcting steep-dip reflection to datum 400 feet lower than bottom of weathered layer, using 8000-foot-per-second elevation correction velocity.

ACKNOWLEDGMENT

This article was prepared for WORLD OIL with permission of Phillips Petroleum Company and is taken from Report 100-3-51R, Research Division, "Remaining Frontiers in the Improvement of Reflection Seismograph Prospecting." Although the author assumes the sole responsibility for any opinions expressed, he wishes to acknowledge his indebtedness to his associates, in particular to Dr. R. G. Piety for many of the ideas contained herein.

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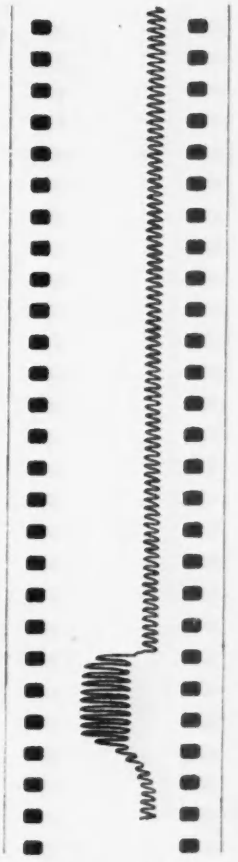

Specimen of tape indicating saturation

Exploration 20 Percent Ahead of 1951 Period

THE industry's search for new oil and gas sources is being carried on at unprecedented rates, and this year's exploratory campaign after two months has accounted for 20 percent more wells than were completed during the same period of record-breaking 1951. Exploratory drilling has shown a substantially greater increase over the previous year than field development drilling which has been hiked only about 5 percent.

During January and February 1597 exploratory tests were finaled to give the year's exploration work a lead of 20 percent over the 1331 wells completed during the same period of last year. A comparison of all wells completed shows 1952 holding an advantage of 7.9 percent; but including only non-exploratory tests, or field development wells, the gain has been only 4.8 percent.

So far, the two exploratory campaigns have shown little difference in success, percentagewise. Two hundred ninety-six were rated as commercial producers out of this year's crop for a score of 18.5 percent of the total drilled. A year earlier, 249 successful tests amounted to 18.7 percent of the overall.

Actually, new oil and gas pools found this year have topped those of last year, both in number and percentagewise. The type of exploratory well that has not lived up to the overall gain has been the field extension well. Discovery of new oil, distillate, and gas pools have exceeded last year's by 22 percent.

Summary of Results of Exploratory Drilling

	Feb., 1952	Jan., 1952	TWO MONTHS January-February 1952	1951	Percent Diff.
Oil Discoveries	102	103	205	169	+ 21.3
New Fields	74	78	152	118	+ 28.8
New Pays	28	25	53	51	+ 3.9
Distillate Discoveries	3	12	15	12	+ 25.0
New Fields	3	10	13	9	+ 44.4
New Pays		2	2	3	— 33.3
Gas Discoveries	22	13	35	28	+ 25.0
New Fields	19	10	29	21	+ 38.1
New Pays	3	3	6	7	— 14.3
Total Discoveries	127	128	255	209	+ 22.0
Extensions to Fields	20	21	41	40	+ 2.5
Oil Fields	16	20	36	29	+ 24.1
Distillate Fields	1	1	2	6	— 66.7
Gas Fields	3		3	5	— 40.0
Total Prod. Tests	147	149	296	249	+ 18.9
Dry Holes	576	725	1,301	1,082	+ 20.2
Wildcats	546	700	1,246	1,017	+ 22.5
New Pays		1	1	4	— 75.0
Outposts	30	24	54	61	— 11.5
Total Expl'tory Tests	723	874	1,597	1,331	+ 20.0
Percent Productive	20.3	17.0	18.5	18.7	
Percent Dry	79.7	83.0	81.5	81.3	

Results of Exploratory Drilling in February and First 2 Months, 1952-1951, by Districts

State or District	MONTH OF FEBRUARY, 1952														FIRST TWO MONTHS, 1952															
	Productive Tests										Unproductive Tests				Productive Tests									Unproductive Tests			Total Dry		Total Exploratory Tests	
	New Fields			New Pays			Extensions			Total Productive					New Fields			New Pays			Extensions									
	Oil	Dis.	Gas	Oil	Dis.	Gas	Oil	Dis.	Gas		Wildcats	New Pays	Outposts	Total Exploratory Tests	Oil	Dis.	Gas	Oil	Dis.	Gas	Oil	Dis.	Gas	2 Mo. 1952	2 Mo. 1951	Wildcats	New Pays	Outposts	2 Mo. 1952	2 Mo. 1951	2 Mo. 1952	2 Mo. 1951
Alabama											2			2	1									1	1	3			3	2	4	3
Arizona																														1		1
Arkansas	2					1				3	2			5	5					2				7		9			9	7	16	7
California	3			3			4			10	35		6	51	4			4			7			15	6	64		8	72	99	87	105
Colorado	2									2	11			13	2			1						3		23			23	16	26	16
Florida											1			1												1			1		1	
Idaho																														1		1
Illinois	2			1			2			5	23			28	5			5			4			14	9	53			53	61	67	70
Indiana	2									2	19			21	3									3	2	30			30	38	33	40
Kansas	8		1	1			1			11	54			65	19		3	1			1			24	30	129			129	105	153	135
Kentucky	1									1	8			9	2						1			3	3	14			14	19	17	22
Louisiana	1		3	2					1	7	16			23	6	2	3	4	1				1	17	19	49		1	50	42	67	61
North Louisiana			3	1					1	5	8			13	2		3	2	1				1	9	6	26		1	27	18	36	24
South Louisiana	1			1						2	8			10	4	2		2						8	13	23			23	24	31	37
Michigan	2					1				3	18			21	4			3		1	1			9	2	32			32	28	41	30
Mississippi	2			1						3	14			17	3			2			2			7	3	32			32	17	39	20
Missouri											1			1												2			2		2	
Montana	1		1							2	5			7	1		1							2	1	9			9	4	11	5
Nebraska											3			3	2						1			3	2	14		1	15	7	18	9
Nevada																														1		1
New Mexico			1				2			3	10			13			2				3			5	8	16	1		17	13	22	21
North Dakota	1									1				1	1									1						1		
Ohio											3			3			1							1	3	5			5	3	6	6
Oklahoma	5		6	4		1	3			19	56			75	10	1	7	6		1	4			29	20	123			123	103	152	123
Pennsylvania											1			1												1			1		1	
Texas	40	3	7	15			4	1	2	72	251		23	346	82	10	12	26	1	2	12	2	2	149	133	616		43	659	496	808	629
Dist. 1 S. Central	2			1						3	25		1	29	3			1						4	4	50		2	52	27	56	31
Dist. 2 Middle Gulf	2			1				1	2	6	21		1	28	5	3	3	2			3	2	2	20	13	43		4	47	32	67	45
Dist. 3 Upper Gulf	3	2	1	4						10	17			27	4	3	1	6		2				16	15	56			56	37	72	52
Dist. 4 L. Gulf-S.W.	2	1	2							5	25		4	34	4	3	4	3	1					15	15	61		7	68	47	83	62
Dist. 5 E. Central											9			9	2									2	2	21			21	33	23	35
Dist. 6 Northeast	1			2			1			4	8		1	13	1	1		4			1			7	5	21		1	22	9	29	14
Dist. 7-B N. Cent.	15		1							16	57		2	75	29		1	1						31	23	133		2	135	125	166	148
Dist. 7-C W. Cent.	4			1			1			6	23			29	9			2			4			15	16	69			69	40	84	56
Dist. 8 West	2			2			2			6	27			33	7			3			3			13	19	64			64	71	77	90
Dist. 9 North	9		3	4						16	39		14	69	18		3	4			1			26	19	89		27	116	73	142	92
Dist. 10 Panhandle																									2	9			9	2	9	4
Utah											6			6											1	6			6	4	6	5
West Virginia																									1						1
Wyoming	2			1						3	7		1	11	2			1						3	5	15		1	16	15	19	20
Total U. S.	74	3	19	28		3	16	1	3	147	546		30	723	152	13	29	53	2	6	36	2	3	296	249	1246	1	54	1301	1082	1597	1331

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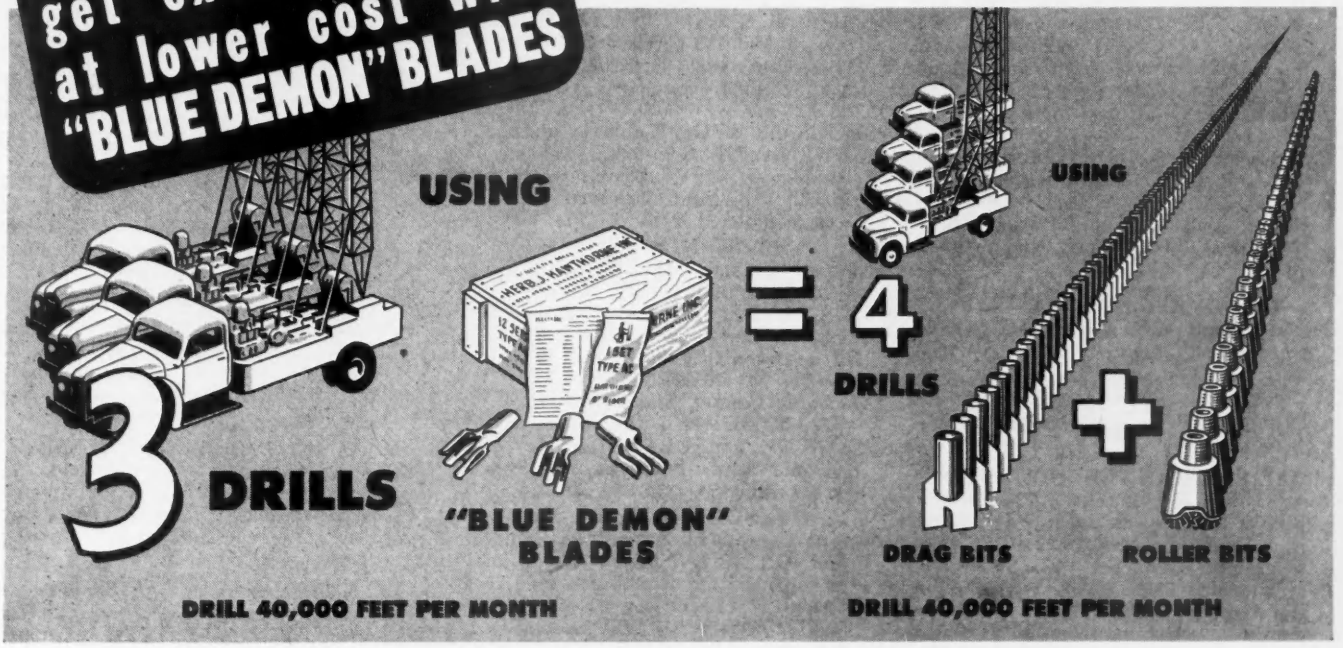

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●

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WRITE FOR ILLUSTRATED CATALOG

HERB J. HAWTHORNE INC.

P. O. BOX 7366, HOUSTON 8, TEXAS

U. S. Oil, Distillate and Gas Discoveries and Extensions in February

ARKANSAS—NEW OIL FIELDS

Columbia County, "Horsehead" field. McAlester Fuel Company's Sam J. McCollum 1-A, C NW NE 22-19s-21w, flowed 84 barrels from Pettit lime, Lower Cretaceous 5850-77 feet, 37.8-gravity, 14/64-inch, completed 2-10-52, TD 11,296.

Lafayette County. The California Company's P. D. Burton Jr. et al 1, C NE NE 9-18s-23w, flowed 279 barrels from Cotton Valley sand, Jurassic 7342-52 feet, 42-gravity, ¼-inch, completed 2-13-52, TD 9564.

ARKANSAS—NEW GAS PAY

Union County, Unnamed field. Murphy Corporation's Sallie 1, C SW SW NW 34-18s-14w, flowed 0.6 million from Lower Sligo lime, Lower Cretaceous 3431-34 feet, 12/64-inch, completed 2-4-52, TD 4005.

CALIFORNIA—NEW OIL FIELDS

Kern County. Pacific Supply Cooperative's Bishop 1, 24-28s-28e, pumped 7 barrels from Pyramid Hills sand 2240-2267 feet, 14-gravity, completed 2-1-52, TD 2600.

Unnamed field, M. R. Peck Drilling Contractor's Beer 1-A, in 7-26s-19e, pumped 2 barrels from 110-10 feet, 11.2-gravity, completed 2-8-52, TD 180.

Santa Barbara County. Murphy Brothers, Limited's Well 1, 34-8n-34w, pumped 30 barrels from Miocene sand, Miocene 3200-3395 feet, 25-gravity, completed 1-27-52, TD 3613.

CALIFORNIA—NEW OIL PAYS

Los Angeles County, Castaic Junction field. Humble Oil & Refining Company's NL&F 8, in 24-4n-17w, flowed 588 barrels from Mohnian sand, Miocene 10,740-992 feet, 29.8-gravity, 1/4-inch, completed 2-1-52, TD 11,080.

Newhall-Townsite field. Continental Oil Company's Braille 1 (OWDD) in 1-3n-16w, pumped 26 barrels from 3259-73 feet, 19.5 gravity, completed 2-13-52, TD 3273.

Orange County, Newport, West field. Pacific Supply's Surf 1, in 13-6s-11w, flowed 121 barrels from Surf sand, 4270-4,330 feet, 24.5-gravity, 18/64-inch, completed 1-22-52, TD 4672.

CALIFORNIA—OIL FIELD EXTENSIONS

Kern County, Antelope Hills field. Shell Oil Company's Hopkins 62X-31, in 31-27s-20e, ½-mile northeast extension, pumped 20 barrels from 2472-95 feet, 32-gravity, completed 1-10-52, TD 2850.

Kern River field. Standard Oil Company's KCL , 29-76, in 7-29s-28e, ½-miele west extension, pumped 8 barerls oil and 2 barrels water from 1695-1748 feet, completed 2-16-52, TD 2000.

Santa Barbara County, Cat Canyon, West field. General Petroleum Corporation's Houk 43-9, in 9-9n-33w, 1½-mile northwest extension, pumped 250 barrels from Monterey shale, Upper Miocene 5880-6528 feet, 10-gravity, completed 1-29-52, TD 6528.

Santa Maria field. Gilliland Oil Company & C. O. Davis' Bradley 5-2 1, (OWWO) in 5-9n-33w, pumped 200 barrels from 4716-4806 feet, 10-gravity, completed 2-19-52, TD 12,094.

COLORADO—NEW OIL FIELDS

Logan County, Springdale, South field. Shell's B. E. Rice 1, NW SW NE 28-8n-53w, flowed 319 barels from Dakota "J" sand, Cretaceous 4870-75 feet, 39-gravity, 3/8-inch, completed 2-15-52, TD 5379.

Sinclair Oil & Gas Company's Parke 1, NW NW NE 6-9n-52w, swabbed 330 barrels oil and 17 barrels water from Muddy "J" sand, Cretaceous 4803-06 feet, completed 2-18-52, TD 4860.

ILLINOIS—NEW OIL FIELDS

Clinton County, New Memphis, South field. J. Kohlbrecker's E. Krausz 1, N½ NE SE 17-1s-5w, pumped 40 barrels oil and 40 barrels water from Devonian lime, Devonian 2000-25 feet, completed 2-5-52, TD 2052.

Macoupin County, Staunton field. R. Updike's G. Groves 1 (OWWO), SE SW 14-7n-7w, pumped 4 barrels from Pennsylvania sand, Pennsylvanian 514-525 feet, completed 2-12-52, TD 525.

ILLINOIS—NEW OIL PAY

Wayne County, Ellery field. D. Baines' F. Piercy 2, NE NW SE 24-2s-9e, pumped 35 barrels from Aux Vases sand, Mississippian 3242-58 feet, completed 2-12-52, TD 3361.

ILLINOIS—OIL FIELD EXTENSIONS

Perry County, Tamaroa field. T. Glass' Zmudzinski 1, NW SW SE 14-4s-1w, 1-mile northeast extension, pumped 38 barrels from Cypress sand, Mississippian 1131-36 feet, completed 2-26-52, TD 1136.

Richland County, Parkersburg Consolidated field. George & Wrather's R. Harmon 1, SE SE SW 29-3n-14w, pumped 22 barrels oil and 2 barrels water from Waltersburg sand, Mississippian 2362-69 feet, completed 2-5-52, TD 3248.

INDIANA—NEW OIL FIELDS

Pike County, "Glezen" field. A Wilson & C. Bradshaw's Ed Dorsam 1, SW SW SW 16-1s-8w, pumped 150 barrels from Benoist sand, Upper Mississippian 1362-65 feet, TD 1365.

Spencer County. James Cal Jones' Norman Kelley 1, SW SW 25-4s-5w, pumped 3 barrels from Tar Springs sand, Mississippian 512-35 feet, TD 536.

KANSAS—NEW OIL FIELDS

Butler County. R. J. Wixson's Brainerd 1, NW NW NW 23-25s-3e, pumped 10 barrels from Mississippi lime, Mississippian 2710-49 feet, TD 2779.

Cowley County, Bergkamp field. Smitherman & Cohen's Bergkamp 1, SW NW SE 6-35s-4e, pumped 74 barrels from Bartlesville sand, Pennsylvanian 3205-25 feet, TD 3225.

Unnamed field. Wentworth & Son's Maddox 1, NW NW NW 13-33s-5e, pumped 10 barrels oil and 15 barrels water from Mississippi lime, Mississippian 3084-91 feet, TD 3091.

Decatur County, Hardesty field. Continental's Hardesty 1, SE NE NE 22-5s-27w, pumped 844 barrels from Lansing-KC lime, Pennsylvanian 3673-3707 feet, TD 4095.

Ellis County, Nicholson, Northwest field. Imperial Petroleum Company's Vance 1, SW SW NW 10-11s-20w, pumped 316 barrels from Lansing-KC lime, Pennsylvanian 3587-94 feet, TD 3844.

Ellsworth County, Maes field. E. K. Carey's Maes 1, SE SW SE 26-17s-8w, pumped 478 barrels from Arbuckle lime, Ordovician 3341-57 feet, TD 3357.

KANSAS—NEW OIL FIELDS

Meade County, Bromwell field. R. E. Adams' Bromwell E, C SW NW 7-34e-29e, pumped 95 barrels from Mississippi lime, Mississippian 5901-08 feet, TD 6180.

Trego County, Sunny Slope field. Deep Rock Oil Corporation's Zeman 1, SE SE SE 21-14s-21w, pumped 248 barrels from Lansing-KC lime, Pennsylvanian 3849-53 feet, TD 3955.

KANSAS—NEW OIL PAY

Pawnee County, Evers field. Iron Drilling Company's Prosser 1, SW SW SW 36-21s-16w, pumped 140 barrels from Arbuckle lime, Ordovician 3906-17 feet, TD 3917.

KANSAS—OIL FIELD EXTENSION

Barber County, Amber Mills field. National Associated Petroleum Company's House 2, SW SW NE 16-30s-12w, pumped 8 barrels from Viola lime, Ordovician 4515-18 feet, TD 4525.

KANSAS—NEW GAS FIELD

Pratt County. Lion Oil Company's Eubank 1, NE NE NE 8-27s-14w, flowed 8.4-million from Lansing-KC lime, Pennsylvanian 3929-36 feet, TD 4646.

KENTUCKY—NEW OIL FIELD

Warren County. Ryan Oil Company's Norman Potter et al 1, in 23-F-35, pumped 10 barrels from Devonian lime, Devonian 1088-96 feet, TD 1207.

NORTH LOUISIANA—NEW OIL PAY

Bossier Parish, Carterville, North field. Stanolind's Nebo Company 1, C NE 15-23n-12w, pumped 17 barrels oil and estimated 141 barrels water from Tokio sand, Upper Cretaceous 3097-3100 feet, 34-gravity, completed 2-13-52, TD 11,262.

NORTH LOUISIANA—NEW GAS FIELDS

Caddo Parish, Fish Lake field. Isbrandtsen Company of Louisiana, Incorporated's Fry et al 1, in 20-15n-11w, flowed 0.8-million and 15 barrels water from Nacatoch sand, Upper Cretaceous 980-85 feet, completed 12-1-51, TD 3015.

Grant Parish. Gulf Refining Company's Colfax Lumber Creosoting Company, Incorporated 1-A, C NE NW NW 36-8n-5w, flowed 1.5-million from Wilcox sand, Eocene 3447-59 feet, ¼-inch, completed 2-20-52, TD 4013.

Union Parish. Southwest Gas Production Company, Incorporated's Foster 1, in 8-19n-2e, flowed 1.5-million from Travis Peak sand, Lower Cretaceous 4905-22 feet, 12/64inch, completed 2-28-52, TD 5250.

NORTH LOUISIANA—GAS FIELD EXTENSION

Bossier Parish, Sligo field. Lion Oil's Maynard 1, 24-18n-12w, 2-mile northwest extension, flowed 21.5-million from Upper Jeter sand, Lower Cretaceous 4433-50 feet, and 14.2-million from Lower Jeter sand, Lower Cretaceous 4504-48 feet, open, completed 2-16-52, TD 5830.

SOUTH LOUISIANA—NEW OIL FIELD

Plaquemines Parish. California Company's State Lease 1958-1, State Lease 1958,

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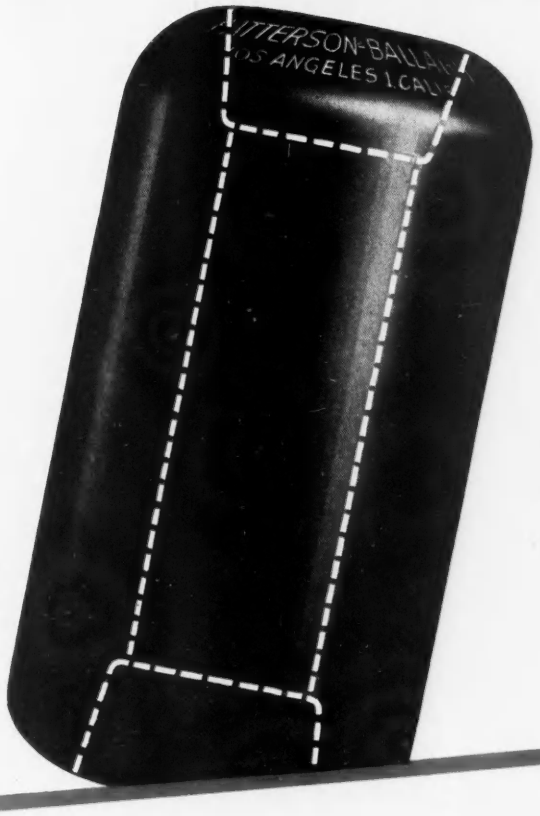

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flowed 244 barrels oil and 106 barrels water from 7528-32 feet, 29-gravity, 1/8-inch, completed 2-22-52, TD 10,000.

SOUTH LOUISIANA—NEW OIL PAY

Jefferson Parish, Little Lake field. Humble's LL&E 1-F, in Section E, flowed 297 barrels from 11,276-279 feet, 37.1-gravity, 1/8-inch, completed 2-8-52, TD 12,118.

MICHIGAN—NEW OIL FIELDS

Allegan County. Cook Drilling Company's Emmons 1, NE SW NW 15-1n-13w, Trowbridge township, pumped 20 barrels from Traverse lime, Devonian 1369-72 feet, TD 1372.

Unnamed field. Walter Creech's Whistler 1, NW SW SE 10-1n-13w, Trowbridge Township, pumped 25 barrels from Traverse lime, Devonian 1330-32 feet, TD 1332.

MICHIGAN—NEW GAS PAY

Osceola County, Mineral Springs field. Walter E. Anderson's Kidder 1, SW SE NE 20-20n-9w, Sherman Township, flowed 20-million from Stray sand, Mississippian 1385-1400 feet, TD 1400.

MISSISSIPPI—FEW OIL FIELDS

Adams County, "Moorland" field. Barnett Serio Drilling Company's Francis Geddes 1-A, in 25-5n-1w, flowed 108 barrels from McKittrick sand, Eocene 6335-38 feet 41.2-gravity, 1/8-inch, completed 2-3-52, TD 6837.

Amite County. "Gillsburg" field. Humble's H. C. Spears 1, C SE SW 27-1n-6e, pumped 86 barrels from Lower Tuscaloosa sand, Upper Cretaceous 11,612-635 feet, 39-gravity, completed 2-15-52, TD 11,891.

MISSISSIPPI—NEW OIL PAY

Franklin County, White Apple, South field. Dave Gammill & Lyle Cashion Company's D. F. Anderson 2, in 3-5n-1e, flowed 175 barrels from Anderson sand, Eocene 6276-83 feet, 38.5-gravity, 1/8-inch, completed 2-4-52, TD 5656.

MONTANA—NEW OIL FIELD

Wibaux County. Shell's Unit 1, C SW NE 30-12n-57w, pumped 346 barrels from Devonian lime, Devonian 8910-70 feet, 33-gravity, completed 2-1-52, TD 9746.

MONTANA—NEW GAS FIELD

Liberty County. Anaconda Copper Company's Blair 1, C E/2 NW 22-34n-4e, flowed 31million from 1765-70 feet, completed 2-4-52, TD 2577.

NEW MEXICO—OIL FIELD EXTENSIONS

Lea County. Brunson. North field. Shell's Chesher 1, in 21-21s-37e, 1-mile east extension, flowed 144 barrels from 6919-7695 feet, 40.8-gravity, 3/8-inch, completed 2-25-52, TD 7695.

Unnamed field. Gulf Oil Corporation's Lea-State 1-H, in 19-15s-33e, 1-mile north extension, pumped 15 barrels from Pennsylvania sand, Pennsylvanian 10,560-750 feet, 36.4-gravity, completed 2-11-52, TD 10,904.

NEW MEXICO—NEW GAS FIELD

Rio Arriba County. Blackwood & Nichols' Alsup 1, SW NE SW 18-30n-4w, flowed 0.8-million from Pictured Cliffs sand, Cretaceous 4168-4350 feet, completed 2-13-52, TD 4355.

NORTH DAKOTA—NEW OIL FIELD

Williams County. Amerada's State 1-A C NE SE 16-156n-95w, flowed 521 barrels from Madison lime, Mississippian 8490-8512 feet, 42-gravity, ¼-inch completed 2-12-52, TD 8595.

OKLAHOMA—NEW OIL FIELDS

Beaver County. Carter Oil Company et al's Sid Sharp 1, C SE SE 31-6n-22e, flowed 936 barrels from Basal Oswego lime, Pennsylvanian 5833-49 feet, 40.4-gravity, 33/64-inch, TD 5867.

Kiowa County, Gotebo, North field. Stanolind's Edith Kennedy 1, SE NE NW 2-7n-16w, pumped 101 barrels from Springer sand, Pennsylvanian 5050-92 feet, 28-gravity, TD 10,044.

Logan County. Coyle. West field. Smith & Cleary's Cohee 1 (OWWO), SE NE SW 7-17n-1e, pumped 25 barrels oil and 7 barrels water from Bartlesville sand, Pennsylvanian 4621-41 feet, TD 5200.

Murray County. Anderson-Prichard Oil Corporation's Letah Myers 1, NW SE SE 2-1s-2e, pumped 12 barrels from Viola lime, Ordovician 2510-50 feet, 27-gravity, TD 4330.

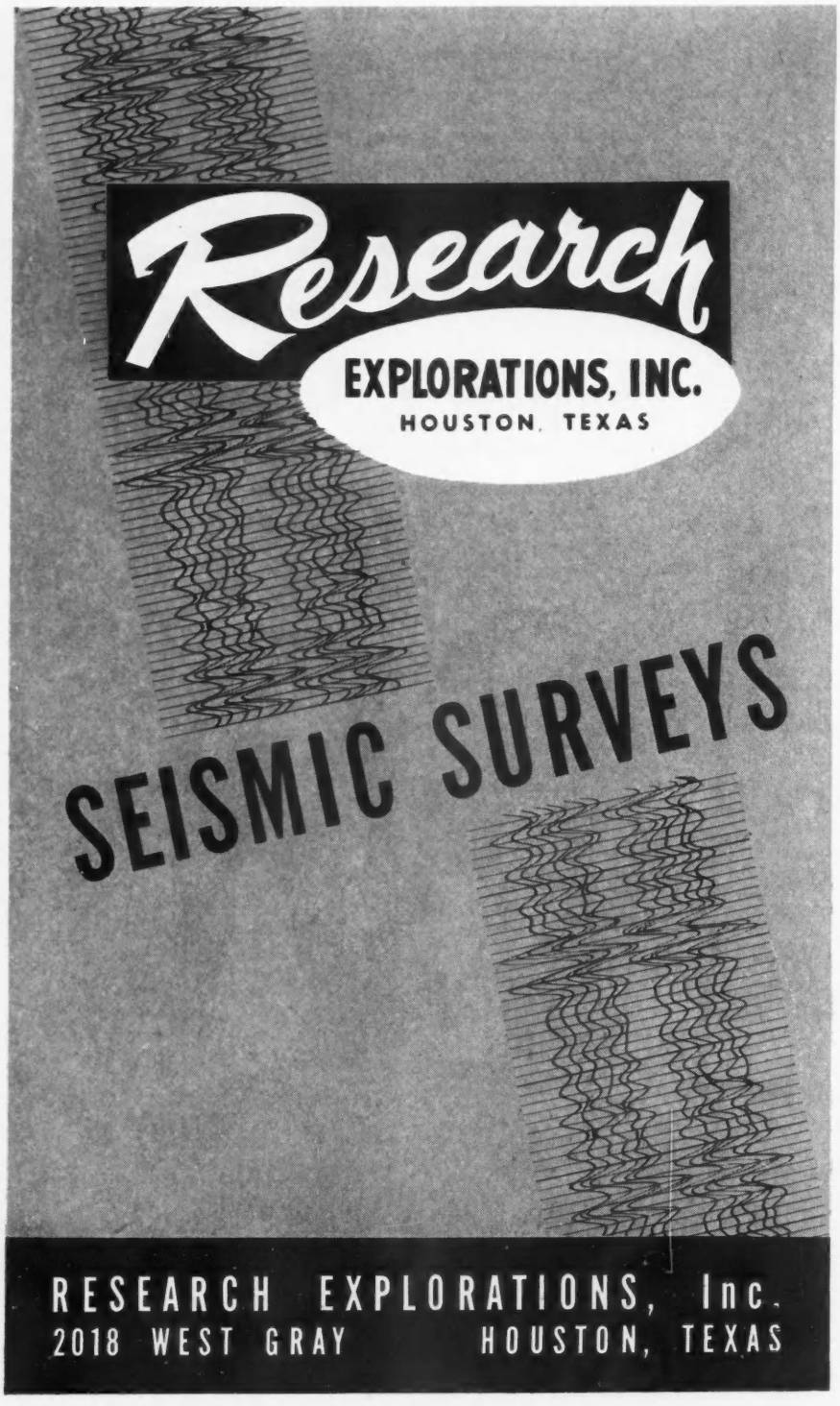
Payne County. Kingwood Oil Company's Speer Heirs 1, NE NE SE 18-17n-3e, pumped 18 barrels oil and 5 barrels water from Lower Skinner sand, Pennsylvanian 4072-78 feet, 37-gravity, TD 4399.

OKLAHOMA—NEW OIL PAYS

Logan County, Lawrie, West field. Davon Oil Company et al's Gooch 1 (OWDD), NW NW NW 14-17n-3w, flowed 114 barrels oil and 96 barrels water from Wilcox sand, Ordovician 6127-30 feet, 15/64-inch, TD 6213.

Okfuskee County, Haydenville field. Frank B. Murta & Son's Raybourne 1, NW NW NW 27-13n-10e, flowed 144 barrels from 2nd Dutcher sand, Pennsylvanian 2822-35 feet, ¼-inch, TD 2835.

Payne County, Lost Creek field. Wilcox Oil Company et al's Caldwell 1, NW NW SE 10-18n-2e, pumped 29 barrels oil and 14 barrels water from Bartles-



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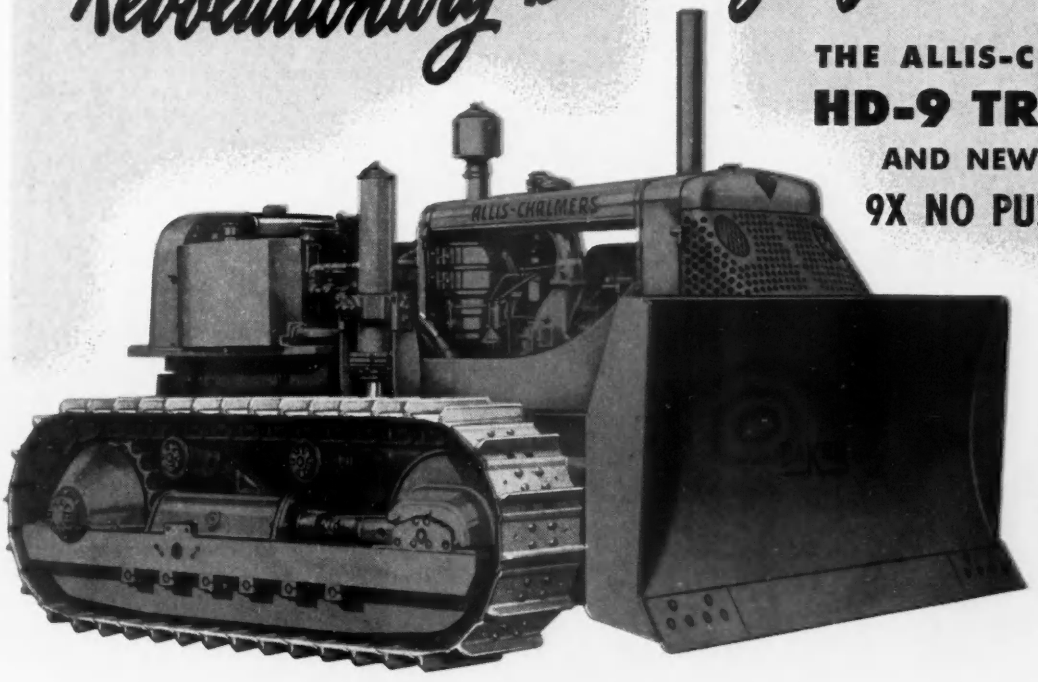

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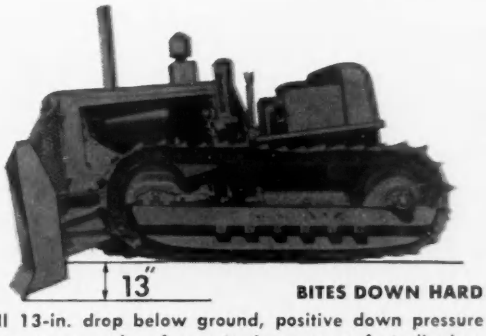

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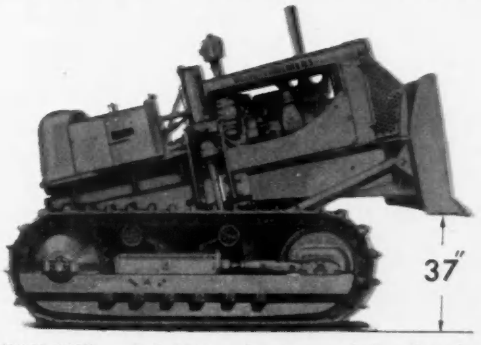

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ville sand, Pennsylvanian 4431-36 feet, 38.5-gravity, TD 4526.

Pottawatomie County, Maud field. Kerr-McGee Oil Industries, Inc's., Zadie 1, NE NW NW 20-8n-5e, flowed 138 barrels from Earlsboro sand, Pennsylvanian 3670-86 feet, 10/64-inch, TD 4328.

OKLAHOMA—OIL FIELD EXTENSIONS

Payne County, Council Creek, Southwest field. Woods Oil & Gas Company, Inc's., Wilson 1, SE SW SW 13-19n-3e, ½-mile west extension, flowed 9 barrels oil and 1 barrel water from Red Fork sand, Pennsylvanian 3746-48 feet, ½-inch, TD 3900.

Schlegel, Northwest field, Arthur Ramsey's Robison 1, NW NE SE 20-18n-6e, ½-mile extension, pumped 11 barrels from Red Fork sand, Pennsylvanian 3140-60 feet, 35-gravity, TD 3240.

Seminole County, Traugh field. R. O. D. Oil Company's J. T. Stewart 1-A, NE NE SW 27-6n-6e, 1-mile southwest extension, pumped 84 barrels oil and 8 barrels water from 2nd Senora sand, Pennsylvanian 2260-76 feet, 34-gravity, TD 2301.

OKLAHOMA—NEW GAS FIELDS

Beckham County. Phillips Petroleum Company's Oran 1-A, SW SW NE 36-8n-26w, flowed 1.4-million from Brown dolomite 1944-88 feet, TD 2013.

Unnamed field. Phillips' Oren 1-B, SW SW NE 28-8n-26w, flowed 0.5-million from Brown dolomite 1929-54 feet, TR 2071.

Unnamed field. Phillips' Hester 1, NW NW SE 4-7n-25w, flowed 1.6-million from Brown dolomite 1907-17 feet, TD 2005.

Unnamed field. Phillips' Puckett 1-A, SW SW NE 33-8n-24w, flowed 0.3-million from Brown dolomite 1638-90 feet, TD 1735.

Hughes County. Public Service Company's Morton 1, C NE SW 18-8n-12e, flowed 0.7-million from Booch sand, Pennsylvanian 2072-98 feet, open, TD 2098.

Lincoln County, Kendrick, Northeast field. George W. Deck et al's Flag 1, (OWWO), NW NE SW 1-15n-5e, flowed 10.5-million from Bartlesville sand, Pennsylvania 3707-32 feet, TD 4420.

OKLAHOMA—NEW GAS PAY

Caddo County, Cement, East field. Little Nick Oil Company's Royce 6, SE NW NE 12-5n-9w, flowed 200 million from Springer sand, Pennsylvanian 6010-6558 feet, TD 6776.

TEXAS DISTRICT 1—NEW OIL FIELDS

Atascosa County. Martin, Shelly & Thomas' Dulaney 1, Dr. Charles F. Simmons Ranch Subdivision, pumped 42 barrels from Carrizo sand, Eocene 1758-62 feet, 20-gravity, completed 2-9-52, TD 1768.

Bastrop County. Thomas Jordan's H. N. Bell, Jr., 1, Albert Black Survey, pumped 151 barrels from Georgetown lime, Lower Cretaceous 3038-3150, 16.8-gravity, completed 12-24-51, TD 3218.

TEXAS DISTRICT 1—NEW OIL PAY

Bastrop County, Unnamed field. Thomas Jordan's H. N. Bell, Jr., 2, Albert Black Survey, pumped 221 barrels from Buda lime, Lower Cretaceous 2847-2920 feet, 16-gravity, completed 2-26-52, TD 3280.

TEXAS DISTRICT 2—NEW OIL FIELDS

Jackson County, "LaSalle, West" field. J. M. Flaitz's John M. Bennett 1, V. Garcia Survey, flowed 178 barrels from Frio sand, Oligocene 6181-85 feet, 41-gravity, 10/64-inch, completed 2-13-52, TD 6354.

Unnamed field. Hassie Hunt Trust's Mrs. Bertha Hasdorff 1, Thomas Menefee Survey, flowed 153 barrels from Frio sand, Oligocene 5800-08 feet, 29-gravity, 9/64-inch, completed 2-6-52, TD 7009.

TEXAS DISTRICT 2—NEW OIL PAY

Calhoun County, Minnie Welder field. John W. Mecom's Welder 13, Jose Maria Rios Survey, flowed 36 barrels from 5348-54 feet, 33-gravity, ⅛-inch, completed 2-8-52, TD 6194.

TEXAS DISTRICT 2—DISTILLATE FIELD EXTENSION

Dewitt County, Helen Gohlke field. Anderson-Prichard Oil Corporation's Albina Bialek 1, T&NO RR Company Survey southwest extension, flowed 35 barrels distillate and 2.8-million gas from Wilcox sand, Eocene 8175-79 feet, ⅛-inch, completed 12-15-51, TD 8412.

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TEXAS DISTRICT 2—GAS FIELD EXTENSIONS

Dewitt County, Henze field. Magnolia Petroleum Company's A. Sinast 1-A, Henry Clark Survey, 1-mile west extension, flowed 15-million from Luling sand, Eocene 7460-65 feet, open, completed 2-18-52, TD 7576.

Live Oak County, Hinnant field. J. Kent Lewis et al's Wilson 1, Michael Boren Survey, ⅔-mile west extension, no gauge from 2170-86 feet, completed 2-5-52, TD 2210.

TEXAS DISTRICT 3—NEW OIL FIELDS

Jefferson County. Hunt Oil Company's Dishman-Lucas 4, William McFarland Survey, flowed 105 barrels from Frio sand, Oligocene 5314-20 feet, 27.2-gravity, 10/64-inch, completed 1-31-52, TD 8757.

Polk County. Jordan Drilling Company & Kraftex Enterprises, Ltd's., Pearl Wiggins 1, G. S. Thomas Survey, flowed 175 barrels from Wilcox sand, Eocene 7841-53 feet, 49.1-gravity, ¼-inch, completed 2-19-52, TD 8257.

Shell's Kirby Lumber Company 1, Tract 125-A, James Stephenson Survey, flowed 49 barrels from Yegua sand, Eocene 5322-40 feet, 44.6-gravity, ⅛-inch, completed 2-4-52, TD 7002.

TEXAS DISTRICT 3—NEW OIL PAYS

Austin County, New Ulm field. Wagner-Werner Company's C. J. Marik et al 1, R. Von Roeder Survey, flowed 182 barrels from 9594-9600 feet, 44.5-gravity, 9/64-inch, completed 2-16-52, TD 10,358.

Chambers County, Fig Ridge, North field. H. R. Smith et al's Texas National Bank of Beaumont 2, T&NO RR Company Survey, flowed 110 barrels from 8399-8403 feet, 37-gravity, ⅛-inch, completed 2-3-52, TD 8490.

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Fayette County, Muldoon field. Hamman Oil & Refining Company's Tupa et al 3, John Vivien League, flowed 108 barrels from Tupa sand, Eocene 2326-333 feet, 21-gravity, 13/64-inch, completed 2-23-52, TD 2333.

Liberty County, Quinn field. Sohio Petroleum Company's B. E. Quinn, Jr., 1 (OWWO), James Humphreys Survey, flowed 92 barrels from Basal Cockfield sand, Eocene 7370-73 feet, 36.8-gravity, 10/64-inch, completed 2-22-52, TD 10,982.

TEXAS DISTRICT 3—NEW DISTILLATE FIELDS

Jefferson County. Deep South Oil Company et al's Security Bank 1, Section 164, Block 48, Ben Son Subdivision, flowed distillate and 14-million gas from 10,058-090 feet, 50.7-gravity, completed 1-12-52, TD 10,307.

Orange County. Gabriel Oil Company's Dartez 1, Theron Strong Survey, flowed distillate and 21.9-million gas from Frio sand, Oligocene 8143-51 feet, 54.2-gravity, open, completed 2-10-52, TD 8912.

TEXAS DISTRICT 3—NEW GAS FIELD

Colorado County. Prince Drilling Company, Inc's., Minarcik 1-A, Samuel Kennelly Survey, no gauge from 9160-73 feet, TD 9186.

TEXAS DISTRICT 4—NEW OIL FIELDS

Duval County. Ben H. G. Coglin's Mae H. King Estate 1, H. H. Garrison Survey, pumped 19 barrels from 1740-50 feet, completed 12-18-51, TD 1751.

Webb County, "Walker" field. O. W. Killam's J. O. Walker 3, Gutierrez Pasture, J. V. Borrego Grant, flowed 74 barrels from Upper Rosenberg sand, Oligocene 1677-87 feet, 25-gravity, completed 2-22-52, TD 2407.

TEXAS DISTRICT 4—NEW DISTILLATE FIELD

San Patricio County. La Gloria Corporation's N. L. Wilson 1, George H. Paul Subdivision, J. J. Welder Ranch, flowed 15 barrels distillate and 6-million gas from Frio sand, Oligocene 5224-33 feet, ¼-inch, completed 2-29-52, TD 6120.

TEXAS DISTRICT 4—NEW GAS FIELDS

Aransas County. Sun Oil Company's Aransas Bay State Tract 67-1, Aransas Bay State Tract 67, flowed 1.7-million from 9608-14 feet, open, completed 1-31-52, TD 10,011.

Kenedy County. La Gloria's Kenedy Ranch 1-A, Rincon del Penascal Grant, flowed 42-million from 7040-70 feet, open, completed 2-8-52, TD 10,500.

TEXAS DISTRICT 6—NEW OIL FIELD

Angelina County, Kurth-Byars field. B. G. Byars & E. L. Kurth's Angelina County Lumber Company 1-A, T. Caro Survey, flowed 87 barrels from Wilcox sand, Eocene 3938-40 feet, 41.1-gravity, ⅛-inch, completed 2-9-52, TD 3940.

TEXAS DISTRICT 6—NEW OIL PAYS

Anderson County, Prairie Lake field. Continental's J. S. Carroll 1-A, E. C. Harris Survey, flowed 34 barrels from Rodessa lime, Lower Cretaceous 8928-46 feet, 47-gravity, ¼-inch, completed 2-20-52, TD 9820.

Houston County, Ralph Spence field. Magnolia's J. M. Murray 1, Daniel McLean Survey, flowed 108 barrels from Sub-

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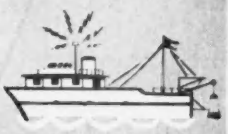

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Clarksville sand, Upper Cretaceous 5778-99 feet, 46-gravity, 3/16-inch, completed 2-13-52, TD 5837.

TEXAS DISTRICT 6—OIL FIELD EXTENSION

Anderson County, Prairie Lake field. Anco Gas Corporation's M. E. Jackson Heirs 1, M. Rionda Survey, 1-mile northeast extension, flowed 114 barrels from 8858-68 feet, 46-gravity, 9/64-inch, completed 2-19-52, TD 9893.

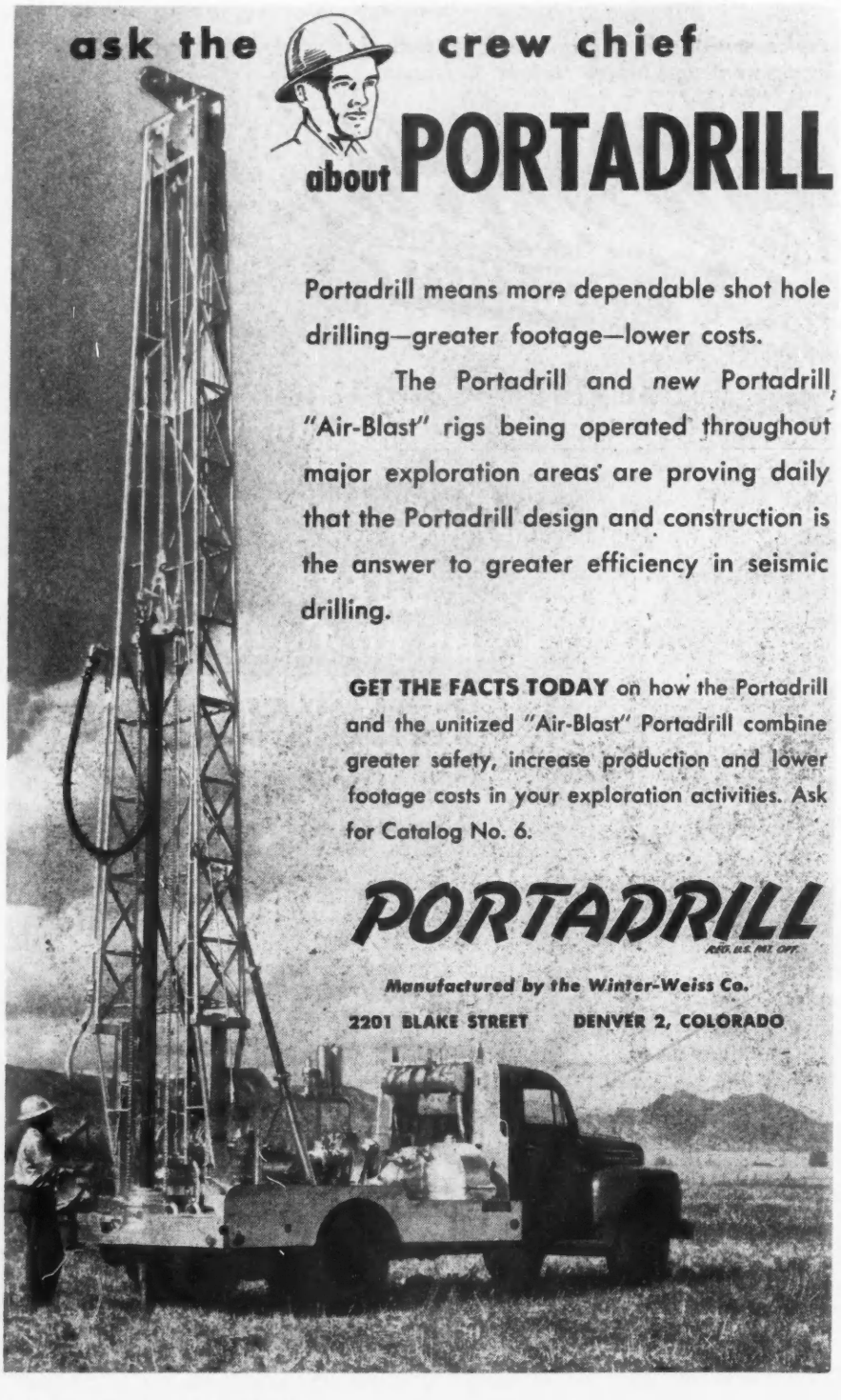
TEXAS DISTRICT 7-C—NEW OIL FIELDS

Reagan County. Humble's Sawyer Cattle 1-J, Section 14, Block A, R. W. McGrew Survey, pumped 70 barrels from Spraberry sand, Permian 5713-5864 feet, 38-gravity, completed 2-5-52, TD 6744.

Runnels County. G. B. Cree's C. E. McMillian 1, Antonio Losoya Survey, flowed 195 barrels from Lower Fry sand, Pennsylvanian 3656-64 feet, 44.2-gravity, 20/64-inch, completed 2-26-52, TD 3940.

Runnels County. Miami Operating Company, Incorporated's Tounget 1, Section 532, Block 32, D. Diaz Survey, pumped 2 barrels oil and 10 barrels water from 3342-47 feet, 41.7-gravity, completed 2-20-52, TD 4259.

Upton County. Sinclair's McElroy Ranch 6, Section 132, Block D, CCSD&RGNG Survey, flowed 65 barrels from Strawn sand, Pennsylvanian 9810-75 feet, 43.3-gravity, open, completed 2-22-52, TD 12,867.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TEXAS DISTRICT 7-C—NEW OIL PAY

Coke County. Jameson field. Chester Hunter's E. E. Stagner 1, in Section 3, S. M. Conner Survey, flowed 141 barrels from Strawn sand, Pennsylvanian 5925-6095 feet, 47.8-gravity, ¼-inch, completed 2-2-52, TD 6407.

TEXAS DISTRICT 7-C—OIL FIELD EXTENSION

Reagan County. Aldwell field. L. B. Jackson Company's F. A. Bird 1, Section 33, Block C, L&SV Survey, 3-mile south extension, pumped 114 barrels from Spraberry sand, Permian 6750-6800 feet, 37-gravity, completed 2-17-52, TD 7710.

TEXAS DISTRICT 8—NEW OIL FIELDS

King County. Stanolind & Ard Drilling Company's T. B. Masterson, Jr. 1, Section 1, TW&NG Survey, pumped 132 barrels oil and 24 barrels water from Upper Canyon Reef lime, Pennsylvanian 4364-67 feet, 38-gravity, completed 2-3-52, TD 4371.

Pecos County. Brown & Thorp Drilling Company's Louise Sanders 1, Section 32, Block 11, H&GN Survey, pumped 2 barrels oil and 10 barrels water from Glorietta lime, Permian 2340-52 feet, 37.2-gravity, completed 2-9-52, TD 3017.

TEXAS DISTRICT 8—NEW OIL PAYS

Andrews County, Noley field. Magnolia's Bertha Noley 1, Section 7, League 314, Gaines CSL Survey, pumped 118 barrels from Wichita-Albany sand, Permian 8129-59 feet, 30.1-gravity, completed 2-8-52, TD 9270.

Borden County, Von Roeder field. Magnolia's W. Ed Murphy 6, Section 69, Block 25, H&TC Survey, pumped 161 barrels from Clearfork sand, Permian 4291-4339 feet, 24.3-gravity, completed 2-7-52, TD 4343.

TEXAS DISTRICT 8—OIL FIELD EXTENSIONS

Cochran County, Bledsoe field. Colin Oil Corporation's Oil Development Company of Texas-Bledsoe 1-A, Section 5, Block Y, PSL Survey, 2/3-mile southeast extension, pumped 62 barrels from San Andres lime, Permian 4831-35 feet, 26-gravity, completed 2-17-52, TD 4845.

Midland County, Tex-Harvey field. Mid-Continent Petroleum Corporation's TXL 1-U, Section 27, Block 38, T-s-S, T&P Survey, 2½-mile southwest extension, flowed 270 barrels from Spraberry sand, Permian 8126-84 feet, 38-gravity, 3/4-inch, completed 2-13-52, TD 8184.

WYOMING—NEW OIL FIELDS

Laramie County. Union Oil Company's Rauner 1, C NE NW 31-14n-60w, pumped 66 barrels from Dakota "J" sand, Cretaceous 7462-7563 feet, completed 2-8-52, TD 7563.

Natrona County. Bruce Anderson & Ozark Oil Corporation's Government 1, NE NW SE 1-36n-82w, flowed 50 barrels oil and 75 barrels water from Tensleep sand, Pennsylvania 3231-45 feet, 23-gravity, completed 2-8-52, TD 3245.

WYOMING—NEW OIL PAY

Fremont County. Happy Springs. Northwest field. Sinclair's Unit 9-B, NW NW NW 8-28n-93w, flowed 400 barrels from Dakota sand, Cretaceous 4610-32 feet, open, completed 2-5-52, TD 4675.

Common Fallacies in Electric Log Interpretation

By DR. R. G. HAMILTON, Tulsa

PAINSTAKING analysis is frequently necessary to obtain the extremely valuable story the electric log has to tell. Careful review of old logs (Figure 1) has resulted in the addition of thousands of barrels of oil to the daily production, while expert analysis of new logs increases the efficiency of well testing procedures and sometimes points the way to oil or gas possibilities that might otherwise be overlooked.

Because the electric log story is not always obvious to the layman, many specialists have entered the well log interpretation field during the past few years. Today, almost every major company employs specialists to interpret critical logs, conduct well log research, and correlate the log information with geologic and reservoir data. Also, log consultants are available to the independent and smaller companies in almost every large oil center.

Competent electric log specialists are thoroughly familiar with the fundamental theories and mathematical approaches in logging, are well informed as to modern developments in interpretative techniques, and possess widespread knowledge of thousands of electric logs. They usually attack the "tough" logs after others, perhaps less experienced, have declined to commit themselves to a definite interpretation. This usually occurs when large sums of money are involved.

In recent years the well logging literature has become abundant and vastly improved analytical methods of interpretation have been perfected. Progressive oil men have eagerly utilized these newer tools, but because of the rapid advances have often found it impossible to become thoroughly familiar with all the factors that must be considered for correct and complete log analysis. As a result, considerable confusion abounds and many misconceptions still are prevalent.

THE UTILITY and value of electric logging is seen as one of the outstanding contributions to oil-finding; however, log interpretation is a laborious and painstaking analytical process rather than a casual chore. In this light, the author has listed many common fallacies which must be respected by the technician when compiling and evaluating log data. The author then presents a step by step procedure for interpreting electric logs, intended to guide the interpreter toward a common sense evaluation.

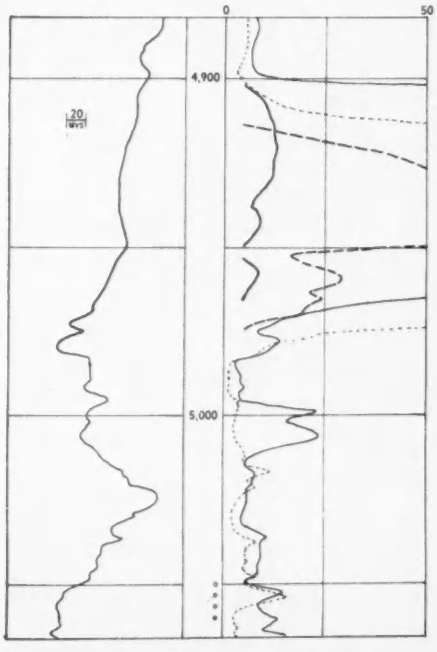


FIGURE 1. This well was plugged in 1946. The electric log was interpreted as indicative of water production in the Wilcox sand. In 1952, on the basis of new geologic studies and a re-interpretation of the log, pipe was cemented in the old hole and perforated from 5050 to 5060 feet. Initial production was 53 barrels of oil per hour and several good offsets have been completed subsequently. RM — 1:8 @ 65° F.; D — 9"; AM — 18"; AO — 13'.

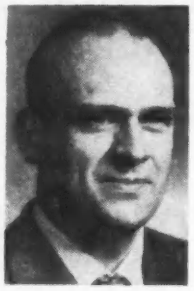
Interpretation Fallacies

Some of the fallacies of log interpretation are tabulated below:

1. High self potential always indicates high porosity and, or, permeability.
2. Low S.P. always indicates poor or negligible porosity and, or, permeability.
3. The effect of bed thickness is of minor importance.
4. The larger S.P. "kicks" are the most important for interpretation.
5. Low S.P. kicks are of little importance and usually indicate non-commercial formations.
6. Minor, local variations in curvature of the S.P. are unimportant.
7. The top or base of a permeable bed is always located one-half the distance from the "shale lime" to the S.P. peak.
8. Apparent high S.P. in limestones or dolomites always indicates good porosity or permeability.
9. The magnitude of the S.P. in limestones and dolomites means nothing.
10. The effect of conductive clay minerals distributed in the interstices is always the same as that of very thin interbedded shale layers.
11. S.P. curves are always free of electrical or mechanical defects.
12. S.P. scales may be assumed to be the same on all logs in a given area or the same from top to bottom of a given log.
13. There is no method of checking the validity of the S.P. scales.
14. The S.P. magnitude is controlled entirely by the mud resistivity.
15. The S.P. curve is meaningless in fresh water sections.
16. "Electrofiltration" or electrokinetic potentials are always negligible in rotary drilled holes.
17. The effect of temperature change

with depth is unimportant.

18. The resistivity of the mud filtrate is always identical to that of the mud.
19. High resistivity always indicates oil or gas saturation.
20. Low resistivity always indicates poor oil or gas saturation.
21. "Negative kicks" on normals always indicate high connate water saturations.
22. Lateral curves have a "depth lag."
23. Deep penetration curves always overcome the effect of mud filtrate invasion.
24. The apparent resistivity is the true formation resistivity.
25. The highest resistivity always indicates the highest hydrocarbon saturation.
26. The lowest resistivity always indicates the poorest hydrocarbon saturation.
27. Marked changes in salinity of formation water of adjacent beds does not appreciably affect the log analysis.
28. It is impossible to detect oil or gas in the fresh water sections.
29. Some of the more recent and additional resistivity curves are merely "sales decorations."
30. Near "oil-water contacts" the best plug back point is the first decrease of resistivity on a non-invaded curve.
31. The apparent slope of the non-invaded resistivity curve is the correct resistivity gradient.
32. It is impossible to obtain even a qualitative interpretation from a lateral curve in the "blind" zone beneath a thin, highly resistive bed.
33. A good "fit" of the plotted apparent resistivity values on a resistivity correction curve immediately provides the true formation resistivity.
34. When correcting apparent resistivity values one may always assume that the more distant electrodes in the borehole exert no influence.
35. One may ignore the stringent rules for use of the resistivity correction curves.
36. The effect of formation dip is unimportant.
37. Minor variations of a resistivity curve have little significance.
38. The effect of drill-stem tests just prior to logging is unimportant.
39. For correlation studies it is unnecessary to consider the electrode spacings, mud resistivity, hole diameters or scales.
40. The same analytical approach may be used for clean sands and sands contaminated with conductive clay materials.



About the Author

DR. R. G. HAMILTON, a partner in the consulting firm of Hamilton and Chombart, Tulsa, was with Schlumberger Well Surveying Corporation for several years before entering business for himself. He headed the Hamilton Well Log Consultants until 1950, when he entered the partnership with L. G. Chombart to specialize in analysis and review interpretation of electric logs. Dr. Hamilton had been Tulsa manager for Schlumberger.

As generalizations, the above statements are fallacious. To avoid errors arising from the acceptance of such generalizations, the careful log analyst gives consideration to numerous factors which determine both the character and the magniture in millivolts and ohm:meters of the S.P. and Resistivity curves of the conventional electric log. This careful consideration will diminish the margin of error likely to be made in the interpretation and will help avoid fallacious assumptions based upon the above, and other fallacies commonly accepted by the interpreter.

Factors to Remember

To interpret an electric log correctly the analyst must not only beware of the fallacies but must take other factors into consideration. The more important factors which are directly related to the bore hole and which must be considered an integral part of electric log interpretation are listed below:

1. Resistivity and temperature of the mud.
2. Chemical nature of the mud.
3. Resistivity and temperature of the mud filtrate.
4. Possible contamination of the bore hole fluid by formation fluid ingress, in rare cases.
5. Accuracy of the mud data reported.

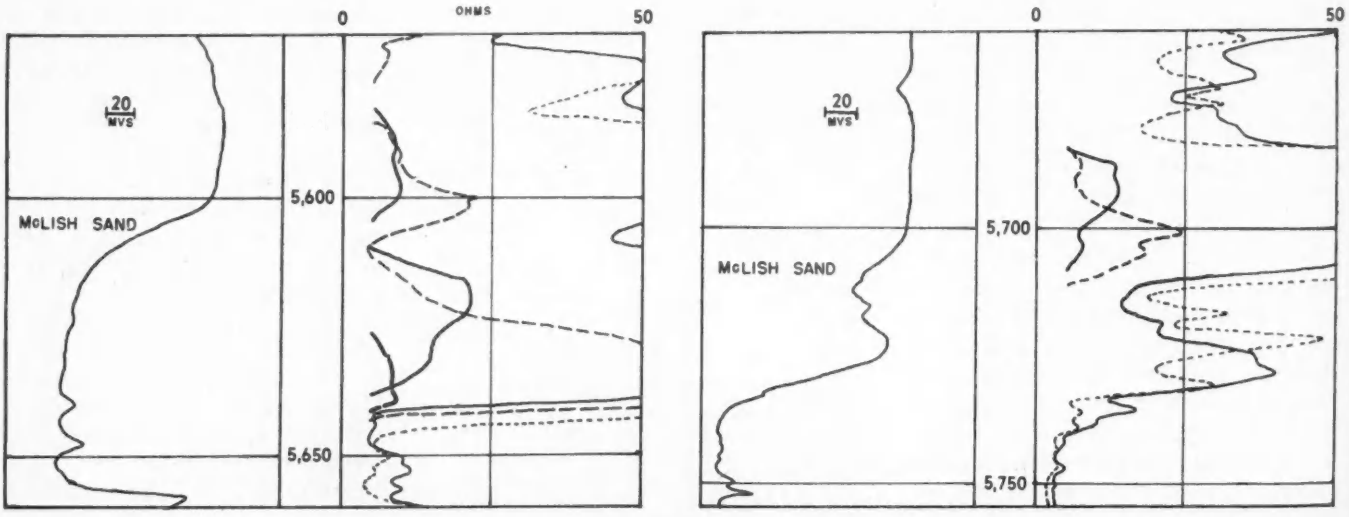


FIGURE 2. Left log: Clean, oil producing McLish sand of high resistivity, above 5640 feet. Clay mineral contaminated, low-resistive oil producing sand below 5640 feet. Rm — 2.4 @ 70° F.; D — 9"; AM — 18"; AO — 13'.
Right log: Clay mineral contaminated oil-producing McLish sand of very low resistivity. Rm — 2.2 @ 68° F.; D — 9"; AM — 18"; AO — 13'.

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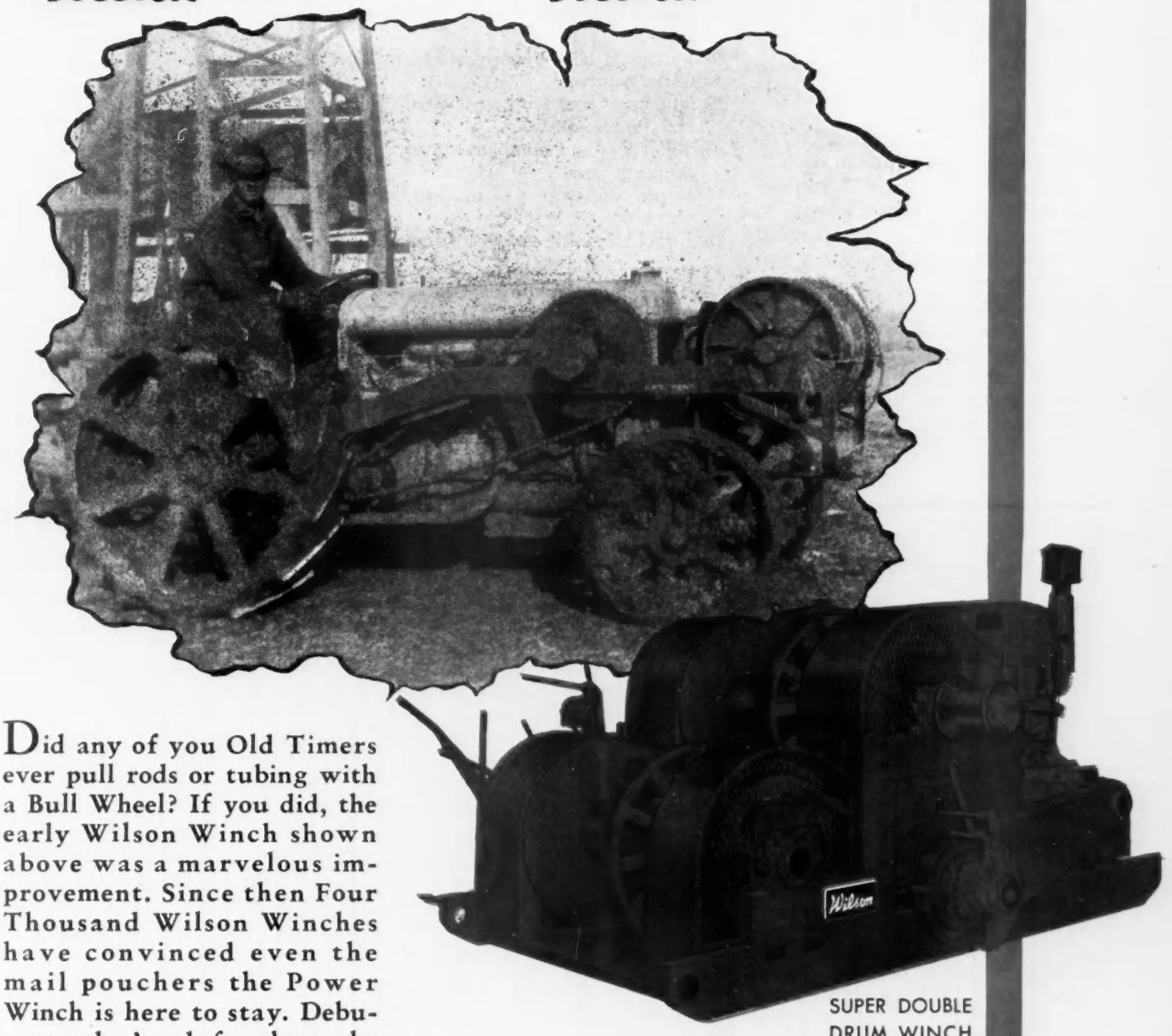

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9. Unusual vertical changes in geothermal and mud thermal gradients.
10. Salinity and resistivity of the formation waters.
11. Bed thickness.
12. Diameter of the borehole.
13. Thickness and distribution of shale layers in a permeable bed.
14. Presence and distribution of conductive clay minerals.
15. Possibility of "electrofiltration" or electrokinetic potentials in the S.P.
16. Possibility of unusual quantities of sulfide minerals in the bed.
17. Unusual changes in the chemical composition of shales above and below a bed.
18. Abrupt changes in salinity of formation waters between adjacent beds.
19. Time interval between drilling and logging of a formation.
20. Resistivity of the invaded zone.
21. True formation resistivity.
22. Porosity of the rock.
23. Percent connate water in the pore space.
24. Thickness of the bed with respect to the electrode spacings.
25. Peculiar characteristics of the resistivity curve employed.
26. Influence of **all** electrodes in the borehole.
27. Ratio of the resistivity of the bed under study to that of the adjacent beds.
28. Electrical homogeneity of the bed under study.
29. Thickness and homogeneity of the bed under study.
30. Thickness and homogeneity of the adjacent beds.
31. Depth and degree of mud filtrate invasion.
32. Effect of drill stem tests made prior to logging.
33. Presence of fracture versus intergranular porosity.
34. Formation factor of the bed.
35. Average cementation factor of the bed.
36. "N" saturation coefficient employed.
37. Selection of the proper resistivity correction curve for obtaining true resistivity.
38. Effect of junk in the wall or at the bottom of the hole.
39. Validity of the log scales.
40. Possibility of extraneous physical, electrical or natural disturbances that might superimpose spurious characteristics on the curve.
41. Existence of unusually steep dips.

When the possible influence of each of the above factors is carefully weighed in the particular situation for each bed under study, electric log interpretation is vastly improved. In the quantitative methods of obtaining porosity, water saturation and permeability, certain assumptions are frequently necessary. Experience and research must determine the validity of the assumption before undue reliance is placed upon the results of the calculations. As a result of the efforts of many log specialists and researchers, such assumptions are usually appropriate and the "electric log story" today is obtained with much greater accuracy.

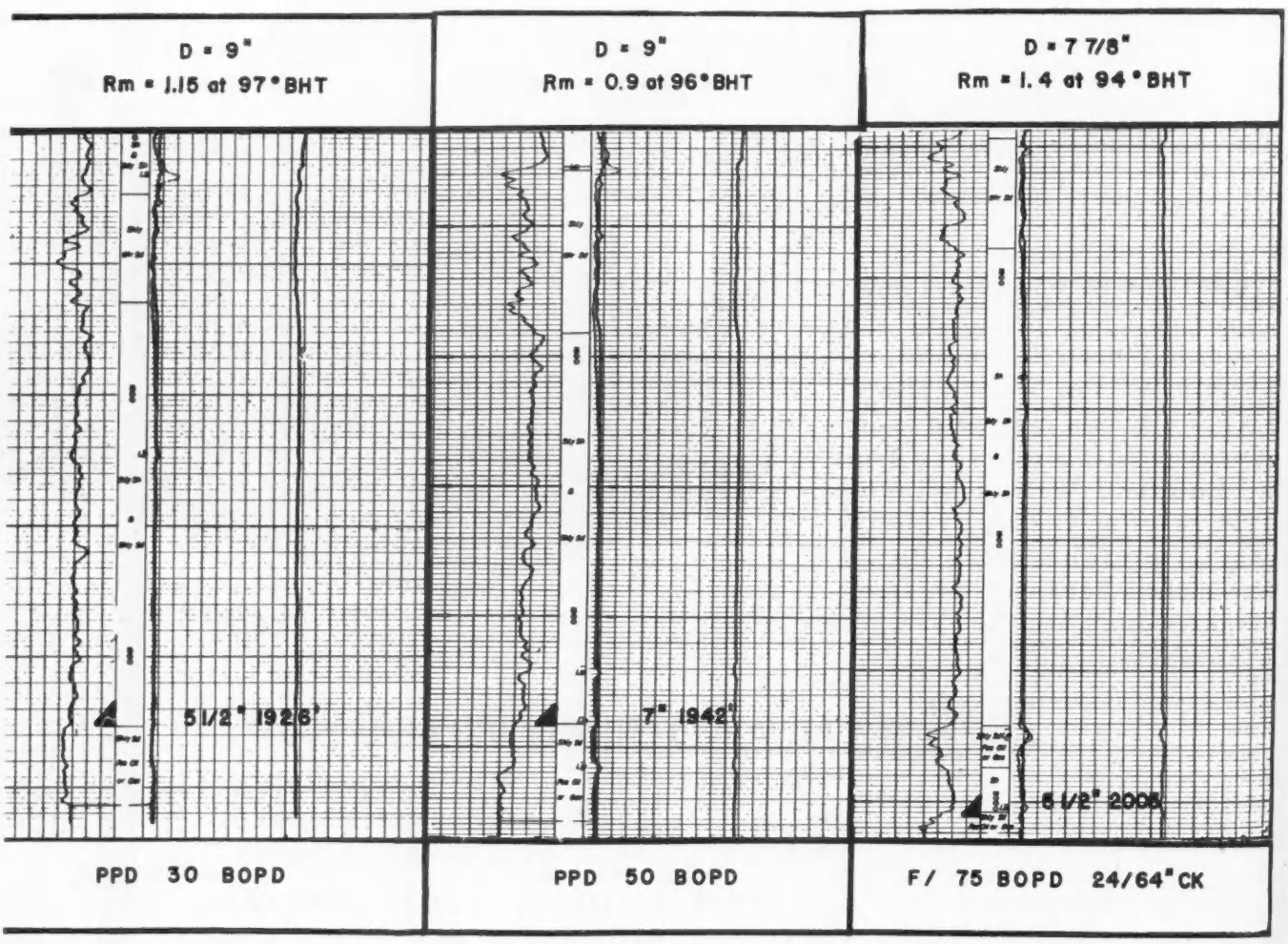

FIGURE 3. The apparent low S.P. of the above oil-producing "sandwiches" of interbedded shale and sand results primarily from the thinness of the layers. If the sandwiches were all sand, the maximum or static S.P. would be 7-80 millivolts.

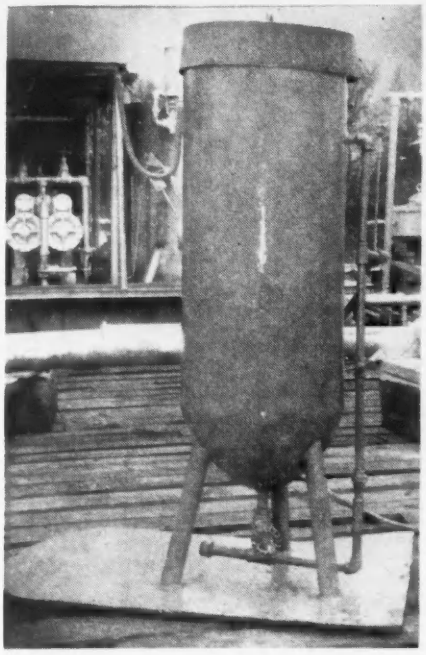

FIGURE 1. View of sand blast air injection system on right side of chamber and metal rod hose hanger welded to the left side. Manipulation of the riser plug valve and the base gate valve permits desired concentration of abrasive flow.

Sand Blast Unit Simplifies Rig Maintenance

By W. L. BROUSSARD

Drilling Tool Foreman, Magnolia Petroleum Company

HERE IS the description of a sand blast unit with a sure fire pay-out. Field constructed for less than $200, the unit is light, simple to operate and easy to construct. In one instance, the author reports that the labor cost for scraping and cleaning a mud tank was reduced from $160 to $24 by using the portable sand blast unit rather than hand tools. Pressure requirements are well within the range of the average rig compressor.

COST of one phase of rig maintenance—removing paint and grease—will be reduced by at least 70 percent if a portable sand blast unit is available on location. Protecting expensive rig equipment is a must for the insurance of long life, efficient service and operating flexibility.

Of basic importance in proper rig maintenance is periodic removal of paint and grease to inspect plate metal or to apply corrosion inhibitor coatings. Not intended as a mere program of rig beautification, thorough and economical removal of such coating permits reapplication of protective coating and an effective repair program, essential to proper machinery operation.

Removing thick coats of flaking, chipped paint and grease is not an economical process by wire brush, scraper or field compounded caustic solutions. The latter technique is also the cause of much concern and anguish to safety supervisors in view of the obvious personnel hazard. Again, the removal of hard set coatings, preparatory to repainting, with hand tools generally encourages smearing fresh paint over rust and grease. The process is unreasonably expensive, while a portable sand blast unit is both economical and effective.

Construction of the shop-made sand blast unit, as shown in Figure 1, represents the optimum in simplicity. The shell of the chamber consists of a five-foot segment of 20-inch casing with the base formed by means of an orange peel weld. Three two-inch pipe legs are cut to conform to the shaped base, then beveled and welded in place to angle project to the one-quarter-inch steel plate base. The dimension of the plate base, which anchors the welded blast chamber legs, can be governed by the type surface the unit will normally rest upon. Incidentally, plans for future blast units include the fastening of small diameter wheels to the base to facilitate ease in rapid movement.

Figure 2 illustrates the manner in which the top of the chamber is countersunk below the uppermost edge with the one-quarter-inch metal tray sloping toward the four-inch collar which has been welded to the tray member. The metal tray is formed at an angle to expedite feeding sand through the four-inch collar and into the blast chamber. Closure of the four-inch opening is possible with either a bull plug or a block made of a short four-inch nipple blanked on the threadless end with formed and welded plate steel. A three-quarter-inch metal bar is welded atop the plug for convenient adjusting.

Since the sloped sand tray has a tendency to collect and trap water or foreign substance, a loose fitting lid, made of light gauge sheet steel with a one-half-inch rod handle welded in the center, caps the unit.

Figure 3 illustrates the interior design of the chamber. Except for the sloped sand tray and the formed base, the entire unit is nothing but a segment of five-inch casing. The air supply line taps the side of the chamber approximately eight inches below the upper edge with a one-half-inch collar welded in place. A ½ x 2-inch nipple extends out from the collar for connecting an ell of comparable size. From this point, the ½-inch riser system includes nipples of the required length with a tee, plug valve and union spaced in the illustrated manner.

An eight-inch nipple, capped with a gate valve, extends from the riser tee for entrance of the compressed air supply. At the base of the riser is another ell which engages the horizontal line leading to a tee, made up running, plus a short nipple, gate valve and another short nipple connecting into a one-half-inch collar welded in the base of the chamber. Installation of these simple fittings completes the job of rigging the sand blast unit for field or shop use. For a longer service expectancy, heavy duty or hydraulic fittings and pipe should be used throughout.

Conditioning the blast sand is a

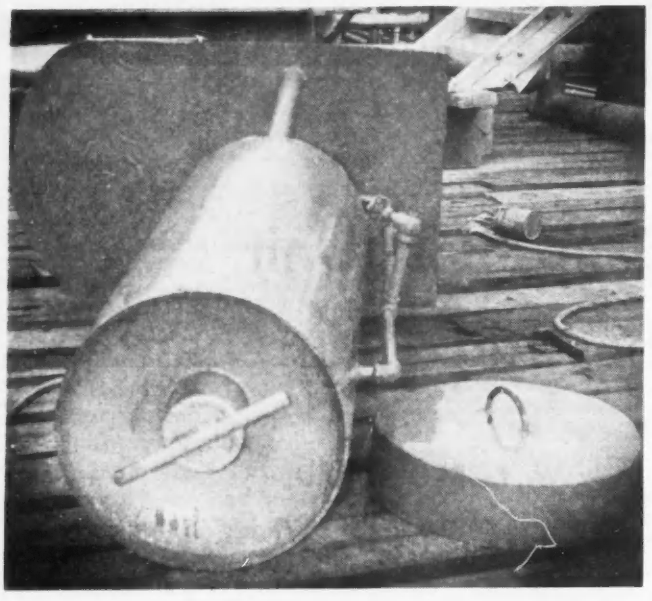

FIGURE 2 (above). Upper section of the five-inch casing chamber is countersunk, angling to a four-inch collar welded in the center. Entrance of rain and foreign matter is blocked by the light gauge lid.

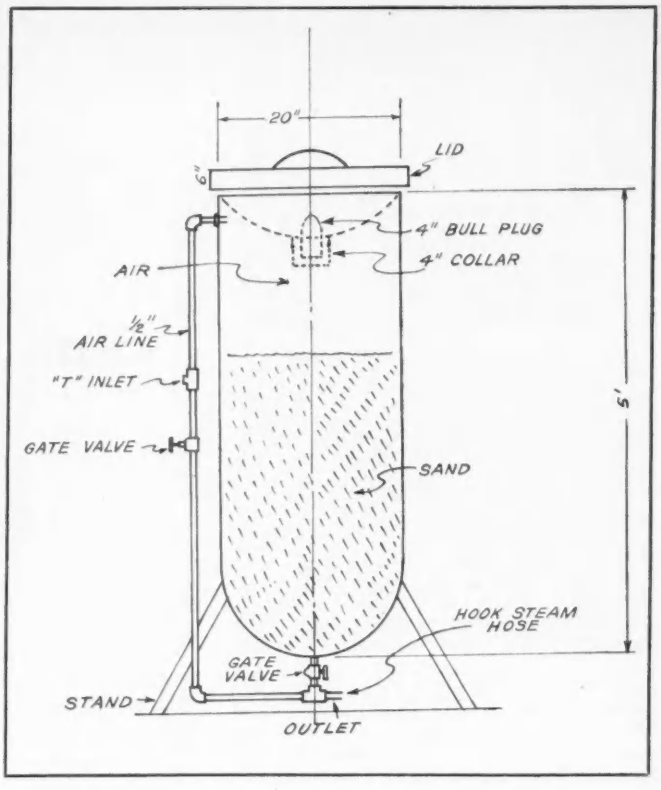

FIGURE 3 (right). Cross-sectional view shows extreme simplicity of sand blast unit. The simultaneous introduction of air pressure above sand body and through jet line assures delivery of adequate supply of abrasive.

preliminary requisite to successful operation. Abrasive must be thoroughly dried and graded through an ordinary screen wire to segregate the smaller pebbles. Sand which falls through the screen is more satisfactory for blasting.

Once the sand is properly processed, it is introduced into the blast chamber through the four-inch opening in the center of the angled tray after the gate valve at the base of the chamber is closed, of course. The chamber can be filled to a point immediately below the air line tap. After charging, the four-inch plug cap is secured, the light metal lid positioned over the top and the hose supply line is connected into the riser fitting. The air supply can be used to an advantage during the charging process by closing the riser valve, attaching the cap plug and injecting pressure against the sand face to assure a compact sand body.

The discharge tee of the blast unit it fitted with a section of one-inch steam or high pressure, heavy duty hose. The blast effect is controlled by the size nipple made up in the end of the hose. In general, a one-quarter-inch nozzle will concentrate the abrasive flow as desired.

The blasting operation is commenced by opening the riser valve and cracking the gate valve below the chamber to a point at which the required quantity of abrasive is delivered through the nozzle. Control of the abrasive or air intensity can be conveniently governed by manipulating the two valves. In practice, the unit is simply a jet system wherein the gravity flow of sand, assisted by the formed base, feeds into the pressured air flow.

Often the operator's objection to sand blast units is that an adequate supply of compressed air is not available; however, it has been found that the conventional rig compressed air system will easily satisfy the demands of the illustrated blast unit. Most power rigs have systems supplying an interrupted flow of air compressed to at least 200 pounds. In turn, a number of steam rigs are equipped in the same manner if only for the purpose of jetting a water well. In either event the average rig air system will easily attend the requirements of this shop-made blast unit.

Economics of Blast Unit

Field or shop fabrication of the blast unit can be completed for well under $200 and amortization is surprisingly rapid. For example, it usually takes five men about 16 hours to brush and scrape the exterior of a 5 x 8 x 38-foot mud tank to bare metal. Expense of this operation will approach $160 for labor alone and the hand bared metal will not be nearly so clean as the blasted surface. In contrast, two men using the blast unit can thoroughly and completely remove a mud- paint- and- grease-crusted coating from the same surface in just six hours. The labor cost for the blasted surface is about $24, or a savings of $136—the near equivalent of the unit's initial construction cost.

The sand blaster is unquestionably of great advantage not only on big heavy duty rigs, but also on lightweight workover units. Although the unit represents another item to handle on rig moves, it is comparatively easy to carry the complete blast chamber atop a load of drill pipe. The lightweight unit can be moved about by two men.

About the Author

W. L. BROUSSARD, drilling tool foreman for Magnolia Petroleum Company, began his career with the company in 1937. Currently in charge of deep well rigs in the Southern Louisiana area, Broussard has been responsible for the design and testing of several new tools in recent years. Prior to his affiliation with Magnolia, he was with the Southern Pacific Railroad as a design engineer.

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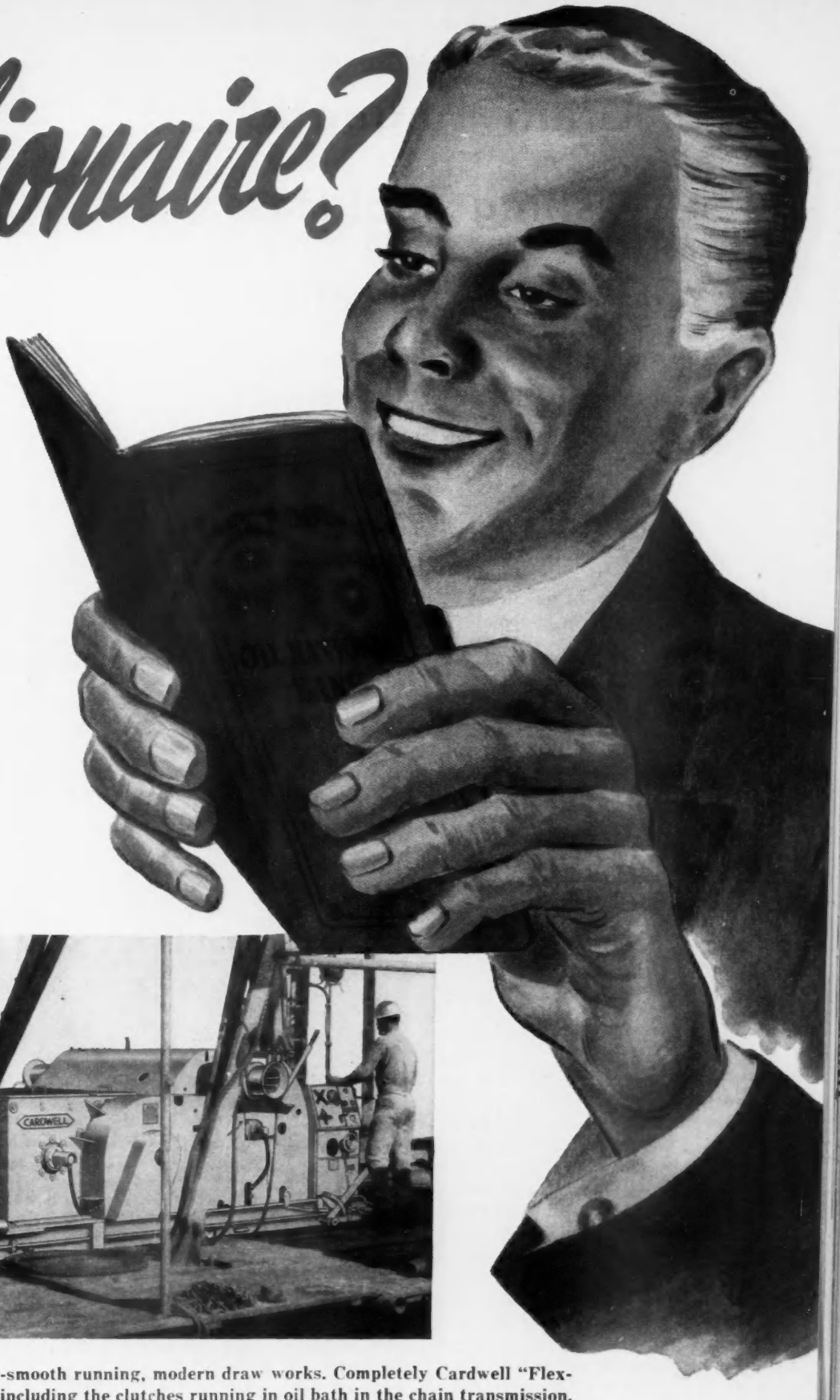

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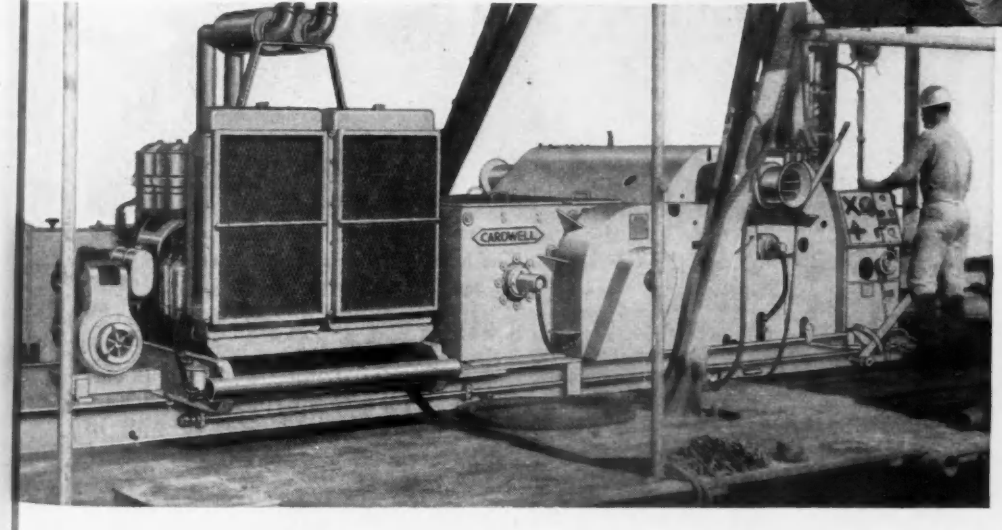

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Giant Magnetic Fishing Tool Has Wide Application

By GEORGE W. J. TROWBRIDGE
Works Director, Kingston Instrument Company, Ltd.,
Surbiton, Surrey, England

THE PROCESS of removing tong keys, hand tools and remnant junk from the well bore has become somewhat simplified through the use of a magnetic tool. Of a permanent nature, the tool can be run on either wire line or drill pipe; the latter technique is preferable, however, since it is possible to circulate during the process. Citing actual field examples of the tool's utility, Trowbridge reports highly successful application in many parts of the world.

FIGURE 1. Group of 4, 5 and 7¼-inch magnets. The larger magnet is shown lifting an inverted rock bit by the cones.

FISHING for awkward pieces of metal such as nuts, tong chains, hand tools, etc., has always been a serious problem in drilling operations. Unless there is proper equipment for the job, fishing often represents expensive delays and loss of footage. With the advent of deeper wells and the corresponding increased use of rock bits, the problem of recovering broken cones and bearings has added another operational hazard for the driller. Cones and bearings can be difficult to recover when the conventional junk basket is used and, to save time, they are often sidetracked in the hole. This is a dangerous practice since the side-tracked parts may fall back into the bore endangering the hole.

To overcome these and other fishing problems electro magnets have, at various times, been considered but have not proved too practical in running in and out of the hole. Permanent magnets have not possessed sufficient power to assure successful operation under many conditions.

This was the position when the Indonesian and Burmese oil fields were recovered from the Japanese at the conclusion of World War II. The bores of these wells had been filled with lengths of rotary chain, tong handles, bit blades, pieces of scrap iron, old valves, center pins of traveling blocks and even live bombs. Conventional fishing tools were tried, but with poor success.

Faced with this problem, H. de Wilde of Shell Petroeum Company was entrusted with the task of developing an adequate magnetic fishing tool and a magnet, with a pull of approximately 20 pounds per square

Table 1

Size Casing (O.D.)	Tool Joint	Total Pull
3⅜ inch	2⅜ inch API IF	100– 120 lbs.
4 inch	2⅜ inch API IF	180– 205 lbs.
4½ inch	2⅜ inch API IF	250– 290 lbs.
4⅞ inch	3½ inch API FH	310– 360 lbs.
5 inch	3½ inch API FH	330 385 lbs.
5½ inch	3½ inch API FH	425– 495 lbs.
6⅝ inch	3½ inch API FH	620– 720 lbs.
7 inch	4½ inch API FH	780– 905 lbs.
7¼ inch	4½ inch API FH	850– 990 lbs.
10 inch	6⅝ inch API FH	1750–2150 lbs.
10½ inch	6⅝ inch API FH	1215–2255 lbs.

inch, was developed and applied in Indonesia and Burma with considerable success.

Use of this giant magnetic fishing tool spread from Indonesia and Burma to fields in India, Assam, the Middle East, England, Holland, France, Germany, North Africa, Trinidad, Venezuela, Colombia, Peru, Bolivia and the Argentine. With refinement of design, materials and method of magnetization, the power of the magnets was increased to 45 psi, and the range of sizes has been extended from one-inch diameter for shot holes, to 10½ inches for oil and water wells.

Construction and Specifications

Figure 1 shows a group of fishing tools which are cylindrical, with protruding polepieces at one end and the tool joint screwed pin or box at the other. The center of the magnet is left clear for circulation of drilling fluid. When not in use the face of the tool is covered by a steel keeper which closes the magnetic circuit. This keeper is jacked away from the face of the tool by means of the four screws, and is removed before the tool is put in operation.

The casing or body of the tool is made of non-magnetic stainless steel. Although various special sizes have been made, the standard range of tools is as shown in Table 1.

In operation the tool can be run on wire line or drill pipe if the operator wishes to utilize the drilling fluid to wash the end of the fish clear and to keep the face of the magnet clean from mud-cake. For light junk and in clean wells the tool can be used on a wire line, but this method, although speedier, is not recommended for the more complicated fishing jobs.

In many areas the magnet is run preliminary to diamond coring. Its use not only cleans the mud of metallic inclusions resulting from rock bit wear or milling operations, but also cleans the bottom of the bore hole. The importance of this is apparent to all users of diamond bits.

Effective Magnetic Strength

One of the most common questions asked in the field is: "How long does the magnetic fishing tool keep its strength?"

Since the magnet elements are of the most advanced material available, the loss of power which takes place after the initial break of the circuit is approximately 3 percent and thereafter the strength remains permanent unless the tool is brought into contact with a de-magnetizing force such as the opposition of another magnet, or is disassembled or subjected to severe mechanical abuse. It has been found that when the tool is run on a wire line the casing of the tool wears more rapidly and needs replacement although the magnet element continues to operate effectively. Magnets have been known to be in use for three to four years and are still in commission although worn on casing and poleface by the abrasive action of the drilling fluid. The magent element can be expected to outlive the mechanical structure of the tool subjected to normal wear and abrasion.

The attraction at the side of the

About the Author

GEORGE W. J. TROWBRIDGE, assistant works manager for Gay's Hampton Ltd. and works manager and director of The Kingston Instrument Company, Ltd., of England, received technical training at Southall Technical School and Acton Technical College. Specializing in precision engineering, tungsten carbide application and oil field equipment, Trowbridge has devoted much time and study to the principle of magnetic fishing tools. His work in the magnetic fishing tool field was accomplished through collaboration with representatives of the Shell Petroleum Company.

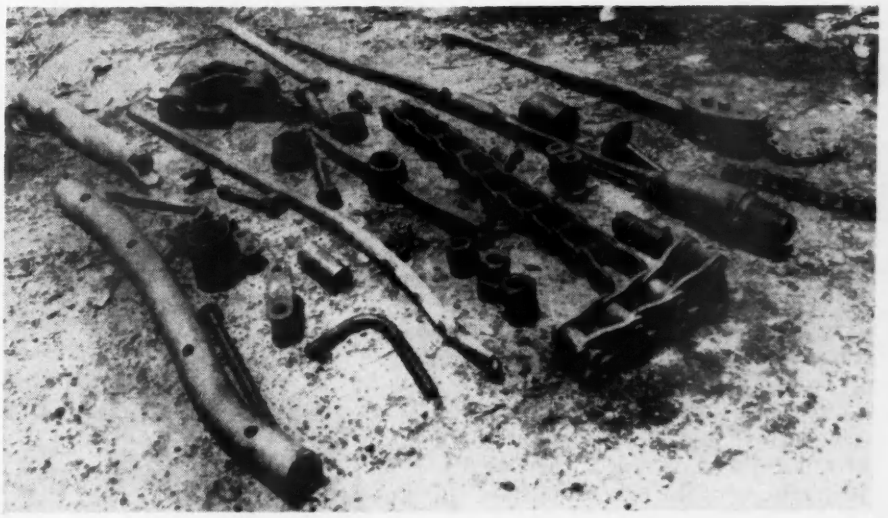


FIGURE 2. Some junk recovered from well bores by magnetic fishing tool.

FIGURE 3. A lost drill collar is removed by a magnetic fishing tool in Chauk oil field operations.

magnet where it comes in contact with the casing is negligible so that it neither magnetizes the casing nor does it cling to it when being lowered in the hole. The magnet elements are magnetized as a built-up assembly and must remain unbroken after magnetizing. During magnetizing, care is taken to insure that the axis shall be through the poleface and the greatest intensity of flux shall be concentrated across the air-gap on this face. It should be remembered that the effect of the earth's field is much greater on the casing than any induced force caused by the passing of the magnetic tool. Drift indicators and survey instruments which may subsequently be passed through the casing following the use of the magnetic tool are in no way affected.

The tool is made with a flat poleface because tests with concave and convex polepieces revealed that in most instances the fish will more satisfactorily offer itself to a flat face.

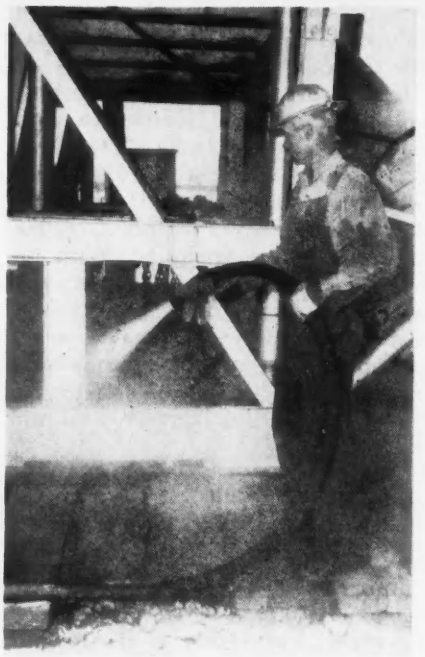
Field Results

The tool, since it was first used in Indonesia and Burma, has had wide application and many interesting results can be cited. The following are a few reports from field operators illustrating results obtained when used under routine drilling conditions:

- While coring at 9248 feet the three cutters of the corehead were left in the hole. A 5¾-inch bit was run to sidetrack the cutters but without success. On pulling out it was found that the three bit cones had also been left in the hole. Three runs were made with the magnetic tool and all junk was recovered except for the bit cones which apparently were sidetracked since they were never recovered and did not interfere with drilling.
- On pulling out core barrel at 10,776 feet, it was found that cutters had been left in the hole. They were recovered after two runs with the magnetic tool.
- Drilling at 5365 feet, rock bit distintegrated, leaving all cutters and legs in the hole. Three runs of the magnetic tool recovered the remainder of the fish and junk.
- Formation tester became stuck in the hole and it was necessary to mill-up most of the fish which was recovered after three runs with the magnetic tool.

The tool, which is a simple piece of equipment and requires no maintenance, has proved very effective in the oil field and in water well operations for the fishing of irregular shaped metallic junk which forms by far the greater proportion of all difficult fishing jobs.

This portable boiler with pneumatic-tired wheels can be easily transported over any type of terrain. Stack is hinged to permit laying it down when unit is moved.



Space heating is but one of many duties assigned to the boiler. Cleaning substructure, tool joints and other equipment are also important around drilling rig.

PORTABLE BOILER Is Multi-Purpose Equipment

By GILBERT M. WILSON, WORLD OIL Staff

MAXIMUM utilization of steam heat generated by a small, portable 40-horsepower boiler is materially adding to the comfort and efficiency of drilling crews on a company-operated rig of a major operator in the West Texas-New Mexico area.

The small boiler is mounted on a light but sturdy trailer chassis with dual, pneumatic-tired wheels. This arrangement serves not only as a stable chassis for over-the-road travel, but assures easy movement over the soft ground and sandy areas frequently encountered in the region.

Spotted at any convenient point a few hundred feet from the well, the boiler unit is set up on blocks, then connected to fuel and steam lines. Lease gas piped from adjacent producing wells is used in the installation shown.

The boiler serves useful purposes in both winter and summer. During the summer, although heat is not required at any point on the rig, the steam is put to such useful and necessary operations as cleaning up rig bases, substructures, tool joints, cleaning of clothes and general lease and equipment cleanup after drilling operations are completed at the location.

A practical flow design has been worked out to obtain maximum efficient use of the steam during winter operations. The design is such that heat is made available at the most important points on the rig and in the approximate order of their importance.

Efficient Flow System

Coming from the boiler, steam is first directed to the heating coils behind the driller's position on the derrick floor. Exhaust from these coils then goes to the heating coils inside the upper doghouse, at the edge of the rig floor. From there, steam exhausts into coils in the change room directly below the doghouse.

The company plans to make still further use of the remaining heat by connecting a line from the change house coils over to the sample house where residual heat could be used to help speed the drying of well cutting samples.

With only slight modifications to suit a particular installation, and at only moderate cost, such a system can easily be adapted to any drilling rig.

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What is a Crooked Hole?

By R. B. McCLOY, Central Division Superintendent,

Stanolind Oil & Gas Company, Oklahoma City

THE ECONOMICS and practicability of holes governed merely by drift angle are becoming recognized as quite doubtful. Herein the author discusses the policy of drift control from the standpoint of over-all hole deviation, drilling economics and closely associated matters. The deviation clause was introduced to the industry in the early 1930's and only minor changes have been made in the method of mapping well bore drift. That vertical deviation in itself is no indication of horizontal displacement is the basic theme of McCloy's work. At the same time it is suggested that there is a dire need for the consideration and alteration of accepted interpretations of drift angle specifications. This paper was presented in March at The American Petroleum Institute's Division of Production spring meeting in Shreveport and Wichita.

SPECIFICATION of drift angle alone does not obtain the results most operators desire and believe they are providing for when using a deviation clause. In short, drift angle cannot be depended upon to assure a reasonably vertical, trouble-free hole and, in many instances an increase in allowable deviation will result in appreciable savings.

Drilling contracts in use by most operators contain a deviation clause which may assume any of the following commonly used forms:

"Contractor agrees to prosecute drilling of said well with due diligence and in accordance with usages and customs of skillful contractors; to make every effort to drill a straight hole and to make or allow the company to make slope tests as frequently and at such intervals as company deems advisable to determine whether slope of the hole or angle of its course from vertical is within the following allowable limits:

- Two degrees to 1000-foot depths;
- Three degrees from 1000- to 3000-foot depths;
- Four degrees from 3000- to 4500-foot depths; and
- Five degrees below 4500 feet;

but in no case is a greater slope to be permitted than the maximum allowed by state regulatory bodies or officials having jurisdiction of such matters in case an allowable slope has been prescribed for the locality or field in which the well is to be drilled. If it is found that the slope of the well is beyond the prescribed allowable limits, contractor, at its own expense, agrees to cement off, redrill or straighten the course of the hole so as to satisfy the above specifications."

"Contractor agrees to drill said hole reasonably vertical from top to bottom thereof to satisfaction of company. Test said hole for deviation from the vertical each 400 feet and at such other points as may be required by company at contractor's expense, by use of a method approved by company. When any such test shows a greater deviation from vertical than ..... (.....) degrees contractor shall, at contractor's expense, redrill the hole and thereby reduce such deviation from the vertical to a degree acceptable to company."

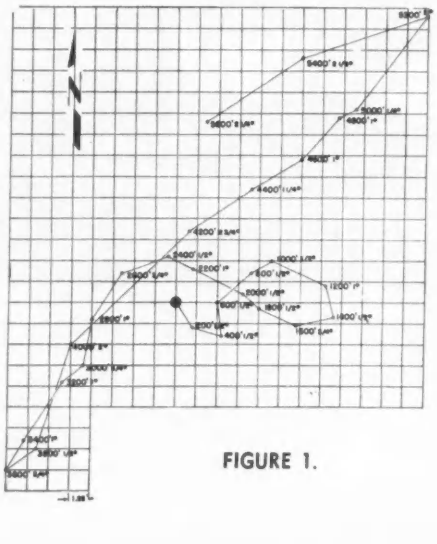

FIGURE 1.

"The contractor assures company a good, clean, straight hole, which shall not deviate more than ..... (.....) degrees from vertical at any point in its course. All surveying shall be done at contractor's risk and expense with an instrument approved by the company, and at intervals to be designated by the company, but in no event at greater intervals than five hundred feet. The contractor shall furnish the company with the original record, instrument reading, or correctly labeled acid bottle of each survey. Contractor shall show the result of each survey on the daily progress report. The company reserves the right to survey the hole with its own equipment at any time during the course of the drilling operation."

Most contracts provide, either in the deviation clause or elsewhere in the contract, that if the hole deviates more than the allowed number of degrees, the contractor shall at his expense plug back and redrill the hole. Of course, there is no assurance that plugging back and redrilling will yield any better results.

The deviation clause had its inception just prior to 1930. The clause resulted from the introduction of equipment and methods to measure vertical deviation. The most popular equipment for measuring deviation was the acid bottle, although electrical and various compass arrangements were used. The use of this equipment indicated that deviations of 20 degrees to 30 degrees were recorded in wells assumed to be vertical. The discovery of this deviation was of great concern to operators due to misinterpretation of geological data, well spacing and extra contract

cost of the deeper deviated hole compared to a shallower vertical hole.

In an attempt to remedy this situation, operators instituted the deviation clause in the drilling contract. Following is a typical deviation clause in use in 1929, quoted by Frederic H. Lahee in his AAPG paper, "Problem of Crooked Holes." The operator is the first party and the contractor the second party.

"First party shall have the right at any time it may desire to make a survey of the well to determine the condition of the hole, at the risk and expense of second party. Such survey shall be made and if the hole is found to deviate as much as 15 degrees from perpendicular, first party may require second party to redrill said hole at second party's expense. If after completion of said well it is surveyed and found to exceed 15 degrees variation from perpendicular, it shall be optional with first party whether or not it accepts the hole, and in case of non-acceptance first party shall not be liable for any expense connected with drilling said well and will be under no obligation to second party."

It will be noted that the allowed deviation was 15 degrees since at the time, improved rock bits and drill collars were not in use. Advances in the art of drilling between 1930 and 1940 made it possible to drill wells with vertical deviations under five degrees so that an allowable deviation of three degrees came into common use. This deviation clause did not cause undue hardship in drilling operations so little was said or done about vertical deviation until recent years.

With the change in drilling practices, areas of activity and the development and common use of improved well-survey instruments, application of the deviation clause again has come into prominence. The main point of concern at the present time is the increased drilling cost resulting from attempting to stay within the drift angle of 3 to 5 degrees normally specified. General disapproval of the drilling contract deviation clause results from the fact that drift angle alone takes no cognizance of rate of change of drift or direction of drift, but defines only the angle from the vertical. It is known that control of drift angle alone does not assure any particular type or pattern of hole and will not assure trouble free drilling or producing operations.

To clarify the limitations of specifying drift angle alone, consider the directional logs presented in Figures 1 and 2. These logs are typical of wells in the Mid-Continent area which are normally drilled with no directional techniques.

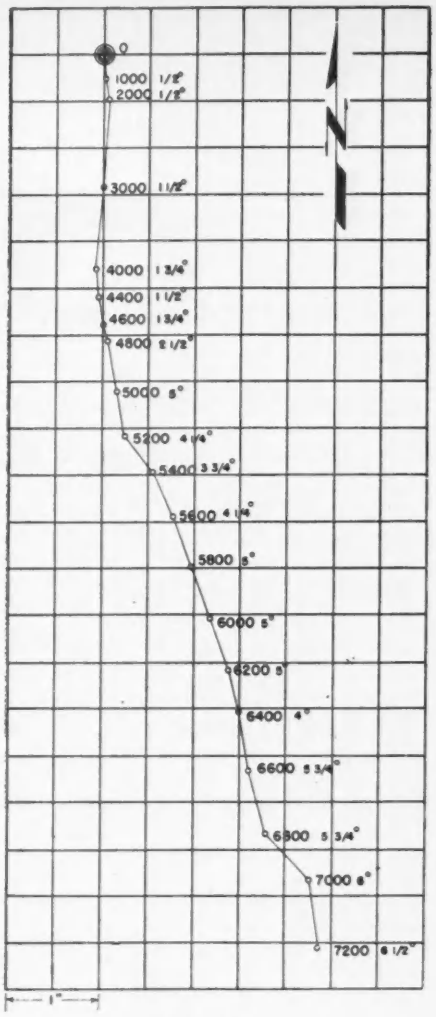

FIGURE 2.

Figure 1 is the directional log of a well in Stephens County, Oklahoma which was drilled in accordance with a contract deviation clause permitting three degrees vertical deviation. The directional survey was plotted from readings taken every 200 feet, and single-shot readings taken while drilling are noted along the course of the directional log. To those not familiar with directional logs, this figure represents the course of the bore hole as observed by projection on a surface horizontal to the derrick floor. To obtain a true picture, the figure must be visualized in three dimensions as the well bore actually occurs. On this log, only one reading is as great as two and three-quarters degrees, the rest are practically all 2 degrees or less; yet, observe the many changes in direction and rapid changes in vertical angle that represent real drilling hazards and later production expense. While drilling, the radical changes of direction will cause keyseats if the rocks are not sufficiently hard and the depth is appreciable. If the rocks are too hard to permit keyseating, then excessive drill pipe wear will be experienced. In producing operations, appreciable rod and tubing wear at the points of rapid change of direction must be the result.

Figure 2 is the directional log of another well drilled in Stephens County, Oklahoma. Again, the log was plotted from readings taken every 200 feet and the single-shot readings taken while drilling are noted along the course of the directional log. In the area of this location, it is not difficult to maintain an angle of three degress to 4500 feet. But below this depth drilling is slow if the angle is held below 5 degrees. To decrease drilling cost, the wells are contracted to 4500 feet with a 3 degree deviation clause; below 4500 feet, they are drilled on a day-rate basis and the angle allowed to build up to not over eight degrees. The financial savings resulting from this practice will be discussed later. The log indicates the well to be one and three-quarters degree from vertical at 4600 feet with the drift angle increasing gradually to six and one-half degrees at 7200 feet. The important feature is that only a slight change of direction occurs between 5200 feet and 5400 feet and no rapid rate of change of drift angle occurs. This well was drilled with no drilling difficulties and it is anticipated that producing operations will not be as expensive as the well presented in Figure 1.

The well presented in Figure 1 meets current popular drilling contract requirements, whereas the well presented in Figure 2 does not. From a comparison of these logs, it is obvious that specification of drift angle alone does not obtain the results most operators desire and believe they are providing for when using a deviation clause.

Figure 3 presents the directional log of a well drilled in Kiowa County, Oklahoma. The log of this well is of importance since round-trip difficulty was encountered in a section of the hole where the drift angle was very low and no difficulty was encountered where the drift angle was relatively high. The drift angle at 3800 feet was two and one-quarter degrees; at 3900 feet was one and three-quarters degrees; and at 4000 feet was three-quarters degrees. The rate of change of angle is less than one degree per hundred feet, which is low. The important point is the change of direction from southeast to northwest. The base of a very hard formation occurs at 3900 feet, and on every trip out of the hole, difficulty was encounter-

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ed working the drill collars through this section. Between 4800 feet and 5000 feet, the drift angle increased from four and one-quarter degrees to six and one-half degrees, or 2 and one-quarter degrees, at a rate not exceeding one and one-half degrees per hundred feet, with no change in direction. With this relatively high drift angle no difficulty was encountered coming off bottom until the drill collars were pulled into the section at 3900 feet. The log of this well is another example that drift angle alone cannot be depended upon to assure a reasonably vertical trouble-free hole.

It is agreed that a comparison of well costs is difficult due to many variables; however, even under the most favorable circumstances, an increase in allowable deviation in certain areas will result in appreciable savings. Some examples:

In Carter County, Oklahoma, two wells were drilled on diagonal 10-acre locations. One well was drilled with a maximum allowable deviation of five degrees, the other was allowed seven degrees. The overall savings on the seven degrees well was $30,000 or, based on the estimated ultimate oil recovery, a savings of 13 cents per barrel. A comparison of two other wells in the same area indicated a savings of $10,000 or, based on the estimated ultimate oil recovery, a savings of seven cents per barrel. These possible savings are often overlooked when compared to the total cost of drilling a well. When converted to the cost-per-barrel of ultimate oil recovery, the savings overshadow many items that receive close scrutiny on a lifting-cost statement. A savings of $10,000 in the cost of drilling a well represents a savings of 10 cents per barrel on a well that recovers 100,000 barrels of oil, or a savings of one cent per barrel on a well that recovers 1,000,000 barrels of oil. Either saving is appreciable when compared to the items under consideration on a lifting-cost statement.

When discussing hole deviation, horizontal displacement should not be ignored. Again, vertical deviation in itself is no indication of horizontal displacement. Only deviation and direction will determine the location of the well bore at any given depth. Horizontal displacement is important in relation to lease lines and well productivity in relatively narrow pinch-out type reservoirs or reservoirs on sharp structures. There is the moral and legal responsibility not to cross lease lines, and the economic responsibility to penetrate the reservoir when it may underlie only a portion of the lease. These factors require a knowledge of horizontal displacement, rather than drift angle alone.

State regulations should be consulted before relaxing vertical deviation requirements. Oil-producing states generally have regulations that govern the permissible vertical deviation. Following is a digest of drift-angle regulations. The information does not pertain to intentionally deviated holes..

About the Author

R. B. McCLOY, central division drilling superintendent for Stanolind Oil & Gas Company, attended Carnegie Institute of Technology and the University of Pittsburgh where he received the B.S. degree in petroleum engineering. Following graduation, McCloy joined Gulf Research and Development Corporation with assignments in geophysical work. After six years he moved to the Gypsy Division, Gulf Oil Corporation, with drilling and production assignments for the following three years. He then joined Union Carbide and Carbon Company and remained with the organization for two years before moving to Stanolind.

ARKANSAS

Less than 150 feet from property line.....3 degrees

Less than 300 feet but more than 150 feet from property line...4 degrees

Over 300 feet from property line.....5 degrees

KANSAS

No state rules govering.

LOUISIANA

Allowable deviation.....3 degrees

MISSISSIPPI

Operator shall file a record of all deviation tests taken. No well shall cross drilling-unit line unless permit is obtained from the state Oil and Gas Board.

NEW MEXICO

If deviation in any 500-foot interval averages more than five degrees, a directional survey must be filed with Commission before any oil or gas is sold.

OKLAHOMA

Shall not unreasonably vary from vertical.

TEXAS

None, except in the East Texas field where deviation is limited to three degrees.

It is hoped that the industry will realize that the deviation clause as now used does not, as many believe, assure a particular type hole or one reasonably free from drilling or producing difficulties. In certain areas the contract requirement to drill a well within the generally accepted deviation limits of three or five degrees may result in costs that greatly exceed those which cause great concern after the well has been placed on production. Presently it is not possible to determine changes in drift angle and direction of drift at the time the changes occur. However, for particularly exacting drilling requirements, specialized equipment is available to determine drift angle and direction of drift at frequent intervals.

For practical everyday use, additional equipment will have to be developed to continuously determine drift and direction of drift. Even with present limitations, the study of directional surveys and drilling rates will reveal areas in which the drilling cost may be reduced without sacrifice by permitting an increase in the allowed deviation.

Further, when drilling deep wells, consideration should be given to running directional surveys at selected intervals so that radical changes in direction or rate of drift may be corrected before drilling has progressed beyond where it is practical to make the necessary correction. If correction were not practical, such surveys would assist in solving drilling difficulties through a more complete understanding of hole conditions.

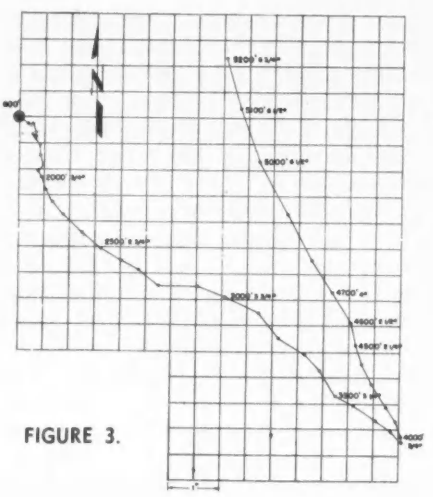
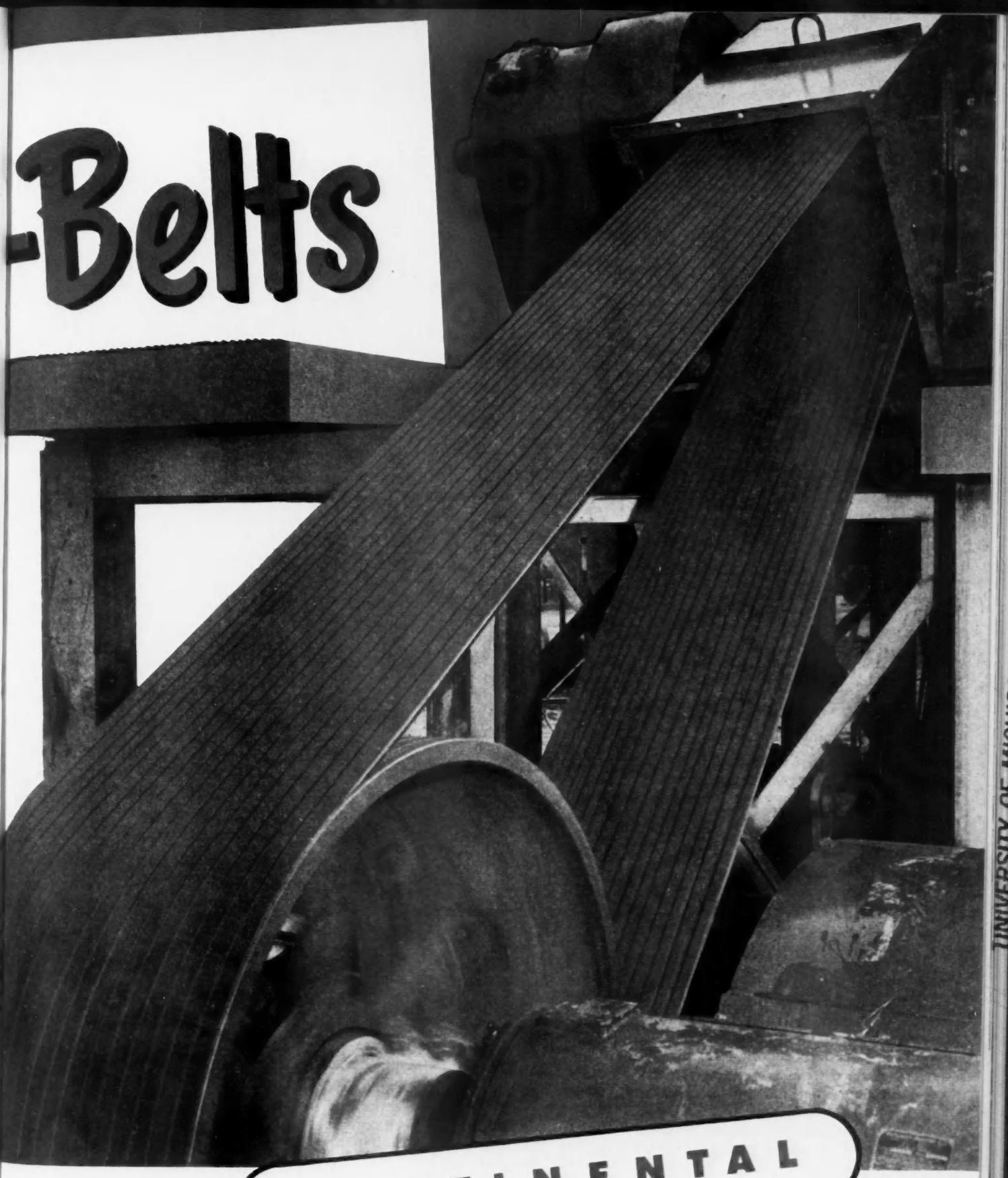


FIGURE 3.



CONTINENTAL

SERVING THE OIL AND GAS INDUSTRIES

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Save That Diesel

With 'Stitch in Time' Maintenance

By J. E. EVERROAD, President
Cummins Sales and Service, Inc.

THIS ARTICLE explains a simple and time-saving method of conducting a diesel engine preventive maintenance program. By compiling data on performance charts, the operator is automatically warned of impending trouble and will be in a position to commence remedial measures prior to the occurrence of damage to engine parts. Intended for the mechanic on a rig or around diesels, the system sets forth the basic fundamentals of intelligent engine care.

PERHAPS it is trite to talk of diesel engine maintenance in terms of the old proverb—"a stitch in time saves nine." However, for diesel preventive maintenance to be of any value, the service men of an organization must feel that engine maintenance must be of the "stitch in time" variety. For owners have found that preventive maintenance, something that everybody talks about and few do anything about, is not actually "preventive" unless it is performed thoroughly and with regularity.

Maintaining a Diesel

Maintaining a diesel engine properly is just like taking good care of an auto. People perform preventive maintenance on cars each time they use them, in having the oil and water and fuel checked as well as electrical units, motor knocks, and other items. Surprisingly, however, the same people expect their diesel engine to give dependable service, with only occasional checks on the operating functions of the engine.

A complete and adequate preventive maintenance program for any diesel engine must include every operation of maintenance needed to obtain maximum periods of trouble free service from the engine and the equipment in which it is mounted at the lowest possible cost.

Such a program cannot be complete and adequate unless it covers every operation needed to prevent possible breakdown or failure of the unit on the job. Breakdowns and emergency repairs are always much more expensive than scheduled repair or rebuilding operations—more expensive in time and material.

It is the objective of every operator then, whether he is a drilling contractor, a hauler, or the operator of fixed diesels in pumping stations, to reduce maintenance to the lowest possible cost. It is demonstrated constantly that low maintenance or operating costs go hand in hand with periodic maintenance.

Too, a preventive maintenance program must be periodic with certain defined rigid limits, or it will become an erratic, haphazard procedure and fail in its purpose. It must also be progressive, with more maintenance as engine use increases, since all service operations need not be performed when an engine is new or recently overhauled. If maintenance operations are so widely separated that trouble develops between service periods, that is proof enough that the intervals are too long or that the service is inadequate. A well planned and well enforced progressive maintenance program combined with intelligent operation will practically eliminate road and power failures and costly emergency repairs.

Consumption of Fuel

Preventive maintenance figures may well be based on gallons of fuel consumed, which makes each engine the guide for its own maintenance. Those figures are based on fuel consumed since the amount of wear on an engine is proportional to the amount of work it performs. Work is easily measured in horsepower hours and is obtained from the fuel consumed.

When a study of fuel consumption curves is made, it is found that certain speed and load ranges are more favorable to work output per gallon of fuel. An engine in good mechanical condition delivers more work per gallon of fuel than one in poor condition. A proper air supply, good fuel and lubrication all tend to increase engine efficiency. Preventive maintenance assures the operator that his engine is in its best possible condition.

Presented herewith is a series of charts which are preventive maintenance check lists. The intervals recommended in the charts may not fit all conditions. They are presented as guides only and may be adjusted to the user's experience. A good maintenance program is one that keeps the engine in first class condition mechanically and anticipates engine part failure before they occur. For the sake of convenience in posting these maintenance records, it is recommended that each check form be established as an individual printed page. In turn, each check form will be introduced with a blank space to record the unit number, time in, time out, date and shift. Field operation of prime movers has proven, without question, that the strict adherence to regular maintenance check reports will assure maximum operating efficiency and extended unit service life.

The initial operation in compiling data on the check forms includes completion of the "Operator's Daily Report" as shown in Figure 1. This

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THE CALIFORNIA WIRE CLOTH CORPORATION—Los Angeles • Oakland • Portland • San Francisco • Seattle • Spokane
WICKWIRE SPENCER STEEL DIVISION—Boston • Buffalo • Chattanooga • Chicago • Detroit • Emlenton (Pa.) • New York • Philadelphia

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PRODUCT OF WICKWIRE SPENCER STEEL DIVISION
THE COLORADO FUEL & IRON CORPORATION

record must be completed following each tour, day or trip, depending upon the type prime mover and service being considered. The next requisite is completion of "Check Form A" illustrated in Figure 2. In the order of their importance, the remaining check forms are as follows:

"B" CHECK FORM—Perform each 500 gallons fuel consumed or equivalent mileage or hour interval.

- ☐ Change lubricating oil.
- ☐ Change the strainer bag or clean the screen stack.
  Inspect the element for bearing metal.
- ☐ Drain sediment from fuel filter case.
- ☐ Check soluble oil and anti-freeze solution, and add as needed.
- ☐ Check and add oil to hydraulic governor, if used.
- ☐ Clean air cleaners, air pre-cleaners and add oil to cups.
- ☐ Clean crankcase breather.
- ☐ Fill fuel tanks.
- ☐ Record oil pressure at 160 degrees water temperature:
  At idling speed _____ psi.
  At governed speed _____ psi.
- ☐ Tighten or check tightness of:
  Lubricating oil lines and connections.
  Fuel lines and connections.
  Water manifold, piping and connections.
- ☐ Determine and correct causes of reported:
  Low lubricating oil pressure.
  Low fuel pressure.
  Abnormal water or oil temperature.
  Unusual engine noise.
  Poor combustion, if evidenced by excessive smoke.

Estimated time; 1.5 hours.
Crew time (2 men): .8 hours.

"C" CHECK FORM—Perform each 1000 gallon fuel consumed or equivalent mileage or hour interval.

- ☐ Change lubricating oil.
- ☐ Change the strainer bag or clean the screen stack.
  Inspect the element for bearing metal.
- ☐ Change lubricating oil filter element.
- ☐ Drain sediment from fuel filter case.
- ☐ Check soluble oil and anti-freeze solution and add as needed.
- ☐ Check and add oil, if needed, to hydraulic governor, if used.
- ☐ Clean air cleaners, air pre-cleaners and add oil to cups.
- ☐ Clean crankcase breather.
- ☐ Fill fuel tanks.
- ☐ Check fuel pump and generator drive chains.
- ☐ Lubricate cranking motor.
- ☐ Lubricate generator.
- ☐ Clean fuel pump screen.
- ☐ Clean fuel inlet connections screens.
- ☐ Check belts for wear, and adjust tension.
- ☐ Determine and correct causes of reported:
  a. Low lubricating oil pressure.
  b. Low fuel pressure.
  c. Abnormal water or oil temperature.
  d. Unusual engine noise.
  e. Poor combustion, if evidenced by excessive smoke.
- ☐ Record oil pressure at 160 degrees water temperature:
  At idling speed _____ psi.
  At governed speed _____ psi.
- ☐ Tighten or check tightness of:
  a. Lubricating oil lines and connections.
  b. Fuel lines and connections.
  c. Water manifold, piping and connections.

Estimated time: 2.5 hours.
Crew time (2 men): 1.3 hours.

"D" CHECK FORM—Preventive maintenance operations. Perform each 2000 gallons fuel consumed or equivalent mileage or hour interval.

- ☐ Steam clean exterior of engine. Protect electric wiring.
- ☐ Flush the crankcase, if needed.
- ☐ Change lubricating oil.
- ☐ Change the strainer bag or clean the screen stack.
  Inspect the element for bearing metal.
- ☐ Change lubricating oil filter element.
- ☐ Change fuel filter.
- ☐ Blow dust and dirt out of generator and cranking motor.
- ☐ Check generator brushes and commutator.
- ☐ Lubricate cranking motor and generator.
- ☐ Check all electric wiring to generator, lights, cranking motor, battery and controls. Tighten and clean connections.
- ☐ Check air and vapor line connections. Clean and tighten.
- ☐ Check and tighten:
  a. Manifold stud nuts.
  b. Cylinder head stud nuts.
  c. Oil pan mounting bolts.
  d. Drive pulleys on shafts.
  e. Engine mounting and bolts.

OPERATOR'S DAILY REPORT

Unit Number_____ Date_____

Type_____ Shift_____

Mileage or Hour Reading at end of Day or Trip_____

Number of Trips_____

Hours Worked_____

Delays_____

Reasons_____

Condition of Equipment_____

Other Remarks_____

Operator_____

FIGURE 1. Completion of the "Operator's Daily Report" should follow each tour, trip or day, depending upon the type prime mover and the service assignment.

"A" CHECK FORM – PREVENTIVE MAINTENANCE OPERATIONS

Perform Each Day or Trip

Unit No._____ Time In_____ Date_____
Time Out_____ Shift_____

- ☐ Check lubricating oil level and add oil, of same brand and weight, as needed.
- ☐ Remove dirt from air pre-cleaner, if used.
- ☐ Clean air cleaners, if engines are operating under extremely dirty conditions.
- ☐ Add oil to air cleaners.
- ☐ Fill fuel tanks.
- ☐ Add engine coolant, if needed, from prepared mixture of 96% water and 4% soluble oil.
- ☐ Determine and correct causes of reported:
  Low lubricating oil pressure
  Low fuel pressure
  Abnormal water or oil temperature
  Unusual engine noise
  Poor combustion, if evidenced by excessive smoke.
- ☐ Visual check all fuel and lubricating oil connections for leaks. Correct as needed.

Notes

Mechanic_____

Inspector_____

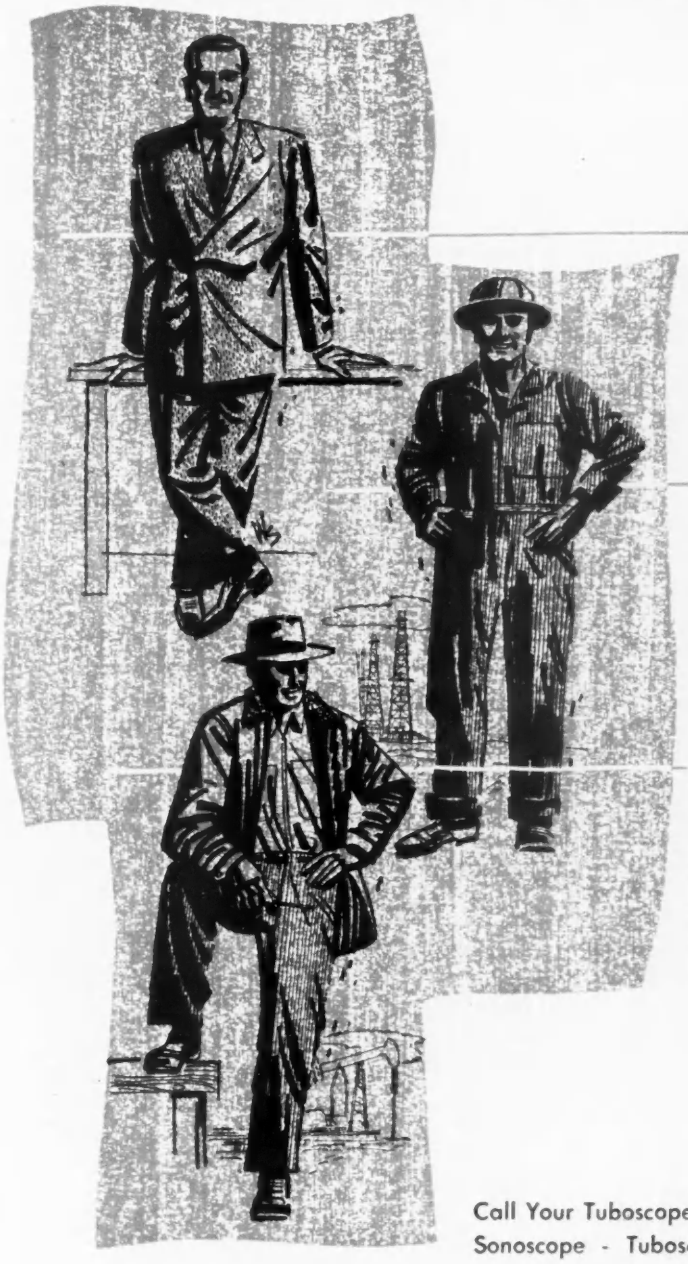
Estimated time .4 Hours
Crew time (2 men) .2 Hours

Use your Instruction Manual

FIGURE 2. Data contained within Check Form "A" will advise the relieving mechanic of the maintenance program promoted during the preceding tour.

Which man are you?

here's how *Tuboscope* can help you reduce drilling costs – stop pipe failures – cut production expenses



MANAGEMENT "With Sonoscope inspection we know we're getting full use out of each length of drill pipe. And the more footage we can get from each length the more we save. Then, too, the chance of twist-offs is almost nil, and that means less expense from downtime. Our cost per foot now is actually down from what it used to be, even with the generally rising cost of doing business."

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- ☐ Check thermal controls.
- ☐ Check soluble oil and anti-freeze solution, and add as needed.
- ☐ Check and add oil, if needed, to hydraulic governor, if used.
- ☐ Clean crankcase breather, air cleaners and pre-cleaners. Add oil to cleaner cups.
- ☐ Fill fuel tanks.
- ☐ Check fuel pump and generator drive chains.
- ☐ Clean fuel pump screen.
- ☐ Clean fuel inlet connections screens.
- ☐ Check belts for wear, and adjust tension.
- ☐ Determine and correct causes of reported:
  - a. Low lubricating oil pressure.
  - b. Low fuel pressure.
  - c. Abnormal water or oil temperature.
  - d. Unusual engine noise.
  - e. Poor combustion, if evidenced by excessive smoke.
- ☐ Inspect upper rollers, injector levers and injector plunger links for lubricating oil loss.
- ☐ Check engine blow-by.
- ☐ Adjust valves and injectors.
- ☐ Inspect supercharger for lubricating oil leaks around seals.
- ☐ Record oil pressure at 160° water temperature:
  At idling speed____psi.
  At governed speed____psi.
- ☐ Tighten or check tightness of:
  - a. Lubricating oil lines and connections.
  - b. Fuel lines and connections.
  - c. Water manifold, piping and connections.

  Estimated time; 5.9 hours.
  Crew time (3 men); 2.0 hours.

"E" CHECK FORM—Preventive maintenance operations. Perform each 4000 gallons fuel consumed, or equivalent mileage or hour interval.

- ☐ Steam clean exterior of engine. Protect electric wiring.
- ☐ Drain and flush radiator.
- ☐ Flush the crankcase, if needed.
- ☐ Check oil level in vibration damper.
- ☐ Change lubricating oil in hydraulic governor, if used.
- ☐ Change lubricating oil.
- ☐ Change the strainer bag or clean the screen stack. Inspect the element for bearing metal.
- ☐ Change lubricating oil filter element.
- ☐ Check crankshaft end clearance with indicator gauge.
- ☐ Change fuel filter.
- ☐ Blow dust and dirt out of generator and cranking motor.

About the Author

J. E. EVERROAD, president and general manager, Cummins Sales & Service, Inc., Fort Worth, began his career as a mechanic on diesel engines in Odessa, Texas, in 1936. He has been instrumental in developing diesel repair methods for the petroleum industry. Before moving to the Southwest, Everroad was connected with Cummins Engine Company at Columbus, Ind., where he worked in the machine and test block shop and later as a field service representative. He attended high school in Columbus and Franklin College at Franklin, Ind.

- ☐ Check generator brushes and commutator.
- ☐ Grease cranking motor drive bearing.
- ☐ Lubricate cranking motor and generator.
- ☐ Check all electric wiring to generator, lights, cranking motor, battery and controls. Tighten and clean connections.
- ☐ Check air and vapor line connections. Clean and tighten.
- ☐ Grease water pump (except NHS) and fan hub.
- ☐ Clean injectors.
- ☐ Check and tighten:
  - a. Manifold stud nuts.
  - b. Cylinder head stud nuts.
  - c. Oil pan mounting bolts.
  - d. Drive pulleys on shafts.
  - e. Engine mounting and bolts.
- ☐ Check thermal controls.
- ☐ Check soluble oil and anti-freeze solution and add as needed.
- ☐ Clean crankcase breather, air cleaners and pre-cleaners. Add oil to cleaner cups.
- ☐ Fill fuel tanks.
- ☐ Check fuel pump and generator drive chains.
- ☐ Clean fuel pump screen.
- ☐ Clean fuel inlet connections screens.
- ☐ Check belts for wear, and adjust tension.
- ☐ Determine and correct causes of reported:
  - a. Low lubricating oil pressure.
  - b. Low fuel pressure.
  - c. Abnormal water or oil temperature.
  - d. Unusual engine noise.
  - e. Poor combustion, if evidenced by excessive smoke.
- ☐ Inspect upper rollers, injector levers and injector plunger links for lubricating oil loss.
- ☐ Check engine blow-by.
- ☐ Adjust valves and injectors.
- ☐ Inspect supercharger for lubricating oil leaks around seals.
- ☐ Record oil pressure at 160° water temperature:
  At idling speed____psi.
  At governed speed____psi.
- ☐ Tighten or check tightness of
  - a. Lubricating oil lines and connections.
  - b. Fuel lines and connections.
  - c. Water manifold, piping and connections.

  Estimated time; 10.4 hours.
  Crew time (3 men); 3.8 hours.

"F" CHECK FORM—Preventive maintenance operations. Perform each 16,000 gallons fuel consumed, or equivalent mileage or hour interval.

- ☐ Steam clean exterior of engine. Protect electric wiring.
- ☐ Drain and flush radiator.
- ☐ Check crankshaft end clearance with indicator gauge.
- ☐ Inspect crankshaft, main bearings and connecting rod.
- ☐ Inspect pistons and liners, and replace if worn beyond limits.
- ☐ Install new piston rings.
- ☐ Remove and clean:
  - a. Heat exchanger, or oil cooler oil pan.
- ☐ Remove the following engine units and replace with rebuilt units:
  - a. Cylinder heads.
  - b. Upper and lower rocker lever housings and levers.
  - c. Lubricating oil pump, if worn.
  - d. Fuel pump.
  - e. Injectors and inlet connections.
  - f. Water pump.
  - g. Superchargers.
  - h. Air compressor.
- ☐ Inspect drive unit bearings and replace units, if needed.
- ☐ Clean air intake and exhaust systems.
- ☐ Blow dust and dirt out of generator and cranking motor.
- ☐ Check generator brushes and commutator.
- ☐ Check all electric wiring to gen-

■ CONTINUED ON PAGE 178

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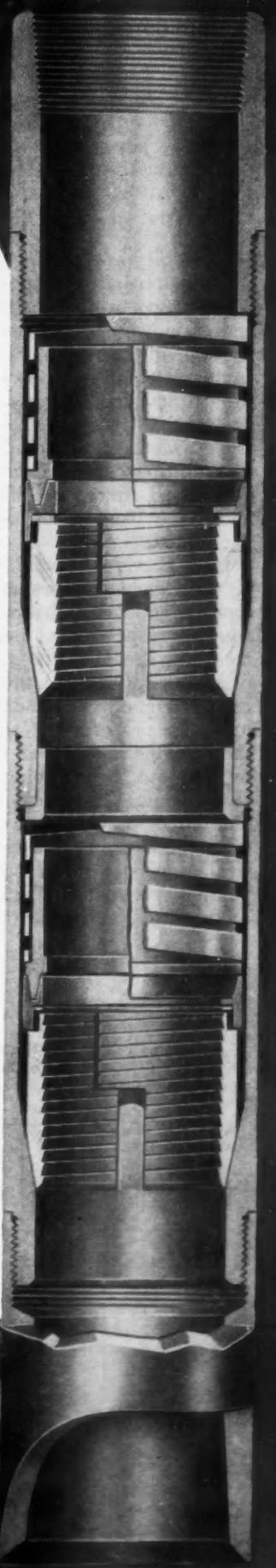

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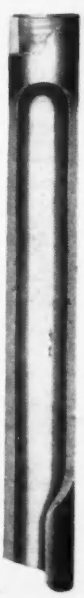
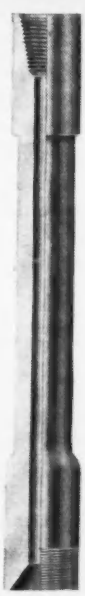


Wall Hook



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Effect of Calcium Sulfate On Properties of a Bentonite Suspension

By W. E. BERGMAN

Research Division, Phillips Petroleum Company

Part 1

IN oil well drilling operations, water-base drilling fluids composed principally of clays dispersed in water have had the most widespread application. For maintenance of desirable physical properties of these muds large expenditures are required by the petroleum industry. An appreciable fraction of these expenditures can be attributed to the deleterious effect of sodium chloride and calcium sulfate encountered during drilling.

In a previous report[2] the control of the rheological properties of one type of simulated drilling fluid—an aqueous suspension of bentonite—by means of the so called alkaline quebracho or tannate treatment was discussed. The effect of sodium chloride upon the properties of the mud was shown. This report is an extension of of that study describing the effect of contamination by calcium sulfate. The effect of $CaSO_4$ in amounts of 0-5 pounds per barrel upon the physical properties of the bentonite suspension pretreated with variable amounts of NaOH with 1-, 3- and 5-pound quebracho per barrel is described in detail. In addition such factors as the effect of technique and of time and temperature of aging are reported and correlated with changes which occur in the concentrations of Ca^{++} and $SO_4^{=}$ in the filtrate from the mud.

ALTHOUGH THE introduction of lime base drilling fluids has done much toward guarding a system against salt or gyp contamination, the industry still finds valuable and widespread use for sodium base muds which are likely to suffer when exposed to such contaminating minerals. Under the circumstances, the battle to protect a drilling fluid from contamination by salts still continues. This article deals with mineral contamination and proven methods for overcoming the damaging results.

Calcium sulfate is encountered as anhydrite or gypsum during drilling. Several reports deal with the effect of this contaminant and discuss Chemical treatment of the mud to maintain satisfactory physical properties [3, 4, 5, 6, 7, 8, 11]. These chemical treatments include the use of sodium carbonate and sodium phosphates for minimizing the effects of relatively small amounts of anhydrite and of barium carbonate or barium hydroxide. The success of treatment with these reagents depends upon either the substitution of one ionic species (Ca^{++} or $SO_4^{=}$) for another less deleterious one (Na^{+} for Ca^{++} or OH^{-} for $SO_4^{=}$) or the relatively complete precipitation of both the Ca^{++} and $SO_4^{=}$ as by treatment with $BaCO_3$. The substitution type of treatment can be successful only for combatting relatively small amounts of the contaminant since formation of a large amount of soluble salt, e.g. Na_2SO_4, may result in adverse rheological properties as well as a high water-

TABLE 1

The Effect of $CaSO_4$ and Na_2SO_4 Upon the Physical Properties of a 30 CPE Suspension of Bentonite and the Change in Physical Properties Upon Aging at 80° C for 18 hours

Test No.	Salt, Lb./Bbl.	API CODE 29 PHYSICAL PROPERTIES — BEFORE AGING: Viscosity, cp/E	Initial Gel Strength, g.	10-Min. Gel Strength, g.	Water-Loss, ml/30-Min.	pH	AFTER AGING AT 80° C. FOR 18 HOURS: Viscosity, cp/E	Initial Gel Strength, g.	10-Min. Gel Strength, g.	Water-Loss, ml/30-Min.	pH	IN FILTRATE OF AGED MUD: HCO_3^-, ppm.	Ca^{++}, ppm.	SO_4^-, ppm.
PART A. ADDED SALT IS CALCIUM SULFATE														
1	0	30	0	30	10.0	8.8	40	2	40	10.0	8.5	280	42	550
2	0.25	52	70	80	9.0	8.7	60	70	100	9.8	8.3	220	44	1295
3	0.50	67	90	120	9.3	8.6	63	90	100	10.5	8.3	210	91	1585
4	1.0	29	20	20	28	8.4	24	15	17	29	8.15	170	368	2990
5	2.0	35	20	20	38	8.4	22.5	18	25	39	8.1	170	547	3500
6	3.0	27	25	25	38	8.4	19	15	15	38	8.1	135	532	3500
7	5.0	27	20	20	39	8.4	20	18	20	40	8.1	75	532	3550
PART B. ADDED SALT IS SODIUM SULFATE														
8	0.5	50	60	80	9.5	8.8	52	50	80	9.6	8.6	....	....	....
9	1.0	68	100	140	10.0	8.8	67	90	140	9.4	8.6	....	....	....
10	3.0	93	120	160	9.0	8.7	90	120	150	9.3	8.5	....	....	....
11	5.0	90	120	170	9.0	8.6	71	120	150	9.0	8.3	....	....	....
12	10.0	(Viscous)			9.0									

loss value. While the alkaline quebracho treatment which is discussed in this report results in the solubilization of anhydrite with the formation of sodium sulfate, field and laboratory experience have demonstrated that this treatment, particularly when used in conjunction with certain water dispersible organic additives such as sodium carboxymethyl cellulose and starch, results in a system which is readily and economically maintained.[2, 5, 6] As a result high-pH quebracho muds have found widespread application for drilling anhydrite formations.

Experimental Procedure

Materials

The reagents used were as follows:

- Bentonite: A comercial product considered to be typical of that used for drilling muds was used. Material from one sack was used for all tests herein described.
- Quebracho: Analysis by the hide powder method gave: 68.45 tannin, 6.8 percent non-tannins, 10.8 percent insolubles and 14.0 percent water. Concentrations of this reagent were corrected for the moisture content.
- Sodium Hydroxide: For tests with muds the chemically pure compound was dispensed as a solution containing 0.5 grams per milliliter. For analytical and other work carbonate-free, standard solutions were used.
- Other Materials: All other reagents were of chemically pure compound grade. The calcium sulfate was the dihydrate, $CaSO_4 \cdot 2H_2O$, supplied as a fine powder (<200 mesh) to facilitate dispersion in the muds. A correction was applied for the water of crystallization. The CaO used for solubilities studies was found to be approximately 92 percent CaO.

Preparation and Treatment of Bentonite Suspensions

For all tests the bentonite was dispersed in distilled water by means of high speed stirring to give a suspension containing 6.2 ± 0.1 percent clay (105 C). The suspension was aged two days or longer while contained in five-gallon glass bottles which were rotated. The stock suspension was then tested and diluted with water, if necessary, such that the viscosity was 30 ± centipoise.

For most tests 350 milliliter aliquots of the 30 centipoise mud were dispensed into pint mason jars by weighing to ±2 grams. Except as otherwise stated—as for tests showing the effect of time and order of addition of reagents—the technique for treatment of the mud was as follows: The quebracho and sodium hydroxide, if any, were added to the mud simultaneously while the suspension was being stirerd. After vigorous stirring for 15 minutes the calcium sulfate was added and stirring continued for 30 minutes before determination of the physical properties in accordance with the precedure outlined in API Code 29.[1] For aging, to simulate the effect of the temperature of a field mud during circulation, aliquots of the muds were sealed in mason jars which were placed in an oven maintained at 80° C. After aging 18±2 hours the muds were cooled to room temperature, restirred 30 minutes and retested.

Preparation of Solutions for Solubility Studies

To correlate data obtained from analysis of filtrates from the bentonite muds, tests were made to determine the effect of various electrolytes upon the solubility of or reaction with cal-

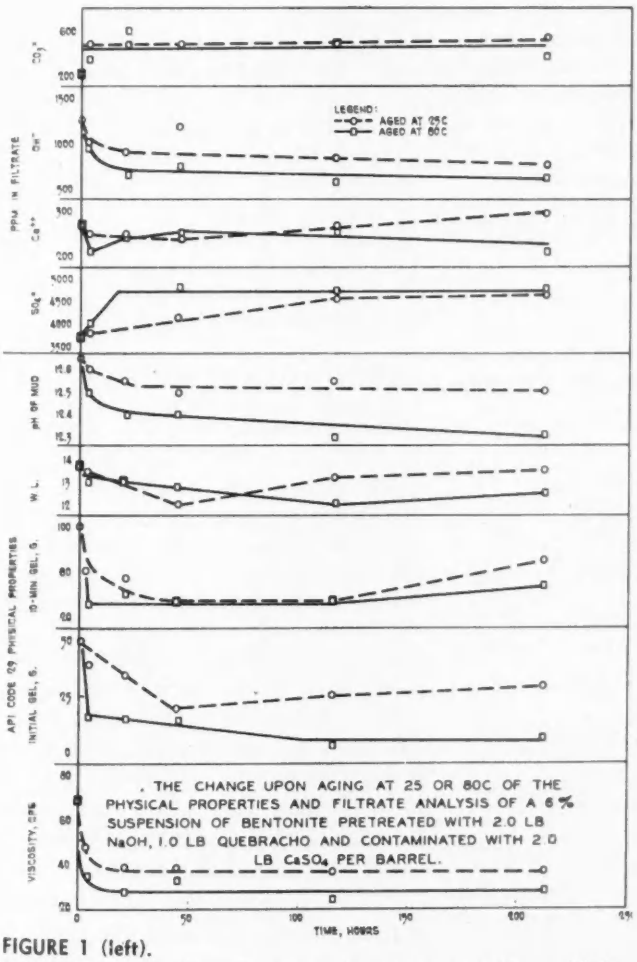
LEGEND:
AGED AT 25C
AGED AT 80C
PPM IN FILTRATE
pH OF MUD
W. L.
API CODE 29 PHYSICAL PROPERTIES
INITIAL GEL, G.
10-MIN GEL, G.
VISCOSITY, CPS.
TIME, HOURS
THE CHANGE UPON AGING AT 25 OR 80C OF THE PHYSICAL PROPERTIES AND FILTRATE ANALYSIS OF A 6 % SUSPENSION OF BENTONITE PRETREATED WITH 2.0 LB NaOH, 1.0 LB QUEBRACHO AND CONTAMINATED WITH 2.0 LB CaSO4 PER BARREL.

FIGURE 1 (left).

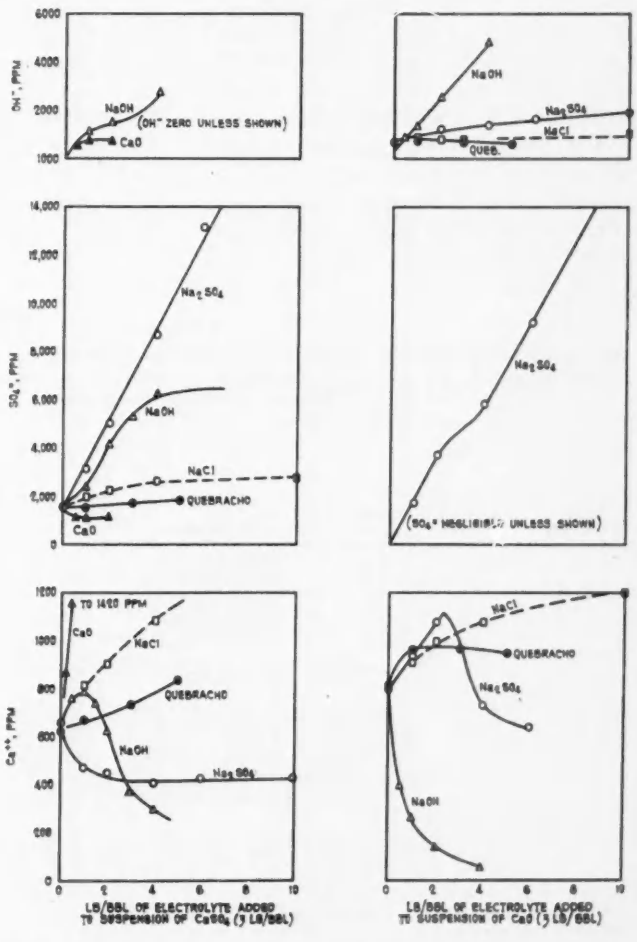

FIGURE 9 (right). Effect of various electrolytes upon the equilibrium at 25 C in aqueous suspensions containing three pounds of $CaSO_4$ of CaO per barrel.

cium sulfate or calcium oxide. For these tests, the quebracho, if any, or other reagent was first hydrated in 100 milliliter of solution containing the desired amount of NaOH. The quebracho, if present, was dispersed by intermittent agitation for one hour in a stoppered Erlenmeyer flask. Simulating the tests with the bentonite suspensions, the $CaSO_4$ (CaO for a few tests) was added last. The suspensions were then agitated intermittently overnight and filtered (API Code 29 paper). Precautions were taken to minimize error due to reaction with carbon dioxide from the air by filtration of alkaline solutions in a CO_2-free atmosphere. The filtrates from these suspensions were analyzed.

Analytical Determinations

For the calcium and sulfate determinations outlined below portions of the filtrates were neutralized with concentrated HCl and clarified by addition of charcoal free of calcium and sulfate. No correction was made for the slight dilution due to neutralization of the filtrates. All results are in terms of parts per million volumes of solution since no correction was made for the density. Numerous control tests have established the validity of these experimental procedures, as outlined below, for the determination of calcium and sulfate in filtrates from drilling muds.

• Calcium: The calcium was determined by precipitation as calcium oxalate using ammonium oxalate and urea to neutralize the acidified solution.[9] The precipitated calcium oxalate was filtered, washed and dissolved in hot 3N H_2SO_4. The dissolved oxalate was titrated with standard permanganate solution. Control tests indicated that the results are accurate to about 15 parts per million. Quebracho, if not removed by charcoal, does not interfere with this procedure. Control tests also proved that no calcium was removed with the quebracho, as by complex formation, if the acidified solution containing quebracho was decolorized with charcoal.

• Sulfate: For most determinations the sulfate was determined by precipitation with benzidine hydrochloride after removal of quebracho.[12] (Validity of this procedure for anlysis of filtrates from drilling muds was proved by E. D. Parsons of the Phillips laboratory.) The precipitated benzidine sulfate was washed with water and titrated with standard NaOH to the phenolphthalein endpoint. The results by this procedure are accurate to about 5 to 10 percent. For some tests, to achieve higher accuracy or to verify what appeared to be anamolies in the data, sulfate was determined gravimetrically as $BaSO_4$.

• Hydroxide, carbonate and bicarbonate: These components were obtained by electrometric titration of five millileter aliquots of the filtrates against standard hydrochloric acid. The end-points for the titration were taken to be at pH 8.6 and 4.2. Quebracho, silicates and aluminates interfere with this procedure. Therefore, the results must be considered only as relative values.

TABLE 2

Illustration of Differences in Physical Properties Achieved by Changing the Length and Temperature of the Aging Period Before Addition of the $CaSO_4$ to the Quebracho Treated Bentonite Suspension.

NaOH, Lb./Bb.	Quebracho, Lb./Bbl.	$CaSO_4$, Lb./Bbl.	Technique*	API CODE 29 PHYSICAL PROPERTIES				
				Viscosity	Initial Gel Strength, g.	10-Min. Gel Strength, g.	Water-Loss-ml/30-Min.	pH
1.0	1.0	1.5	A	30	3	60	12.2	12.0
1.0	1.0	1.5	B	14.5	0	25	10.7	9.95
1.0	1.0	1.5	C	23	0	45	....	11.2
1.0	1.0	2.0	A	42	40	65	13.3	11.95
1.0	1.0	2.0	B	30	0	25	17.8	10.05
1.0	1.0	2.0	C	24	0	130	....	11.2
3.0	1.0	1.5	A	36	15	65	13.0	12.9
3.0	1.0	1.5	B	19	0	8	11.7	12.62
3.0	1.0	1.5	C	26	0	50	....	12.7
3.0	1.0	2.0	A	45	40	80	14.2	12.8
3.0	1.0	2.0	B	15	0	10	12.2	12.6
3.0	1.0	2.0	C	40	10	50	14.0	12.65
3.0	3.0	2.0	A	27	0	35	8.0	12.6
3.0	3.0	2.0	B	20	0	0	9.5	12.2
3.0	3.0	2.0	C	25	0	0	....	12.4
3.0	3.0	3.0	A	45	15	90	7.7	12.5
3.0	3.0	3.0	B	22.5	0	80	....	12.3
3.0	3.0	3.0	C	37	0	30	....	12.4

*For Technique A the $CaSO_4$ was added 15 minutes after stirring in the NaOH and quebracho. After an additional stirring of 30 minutes the mud was tested. Technique B gives the results of the procedure by Technique A except that the treated mud was aged 18 hours at 80° C., cooled, and stirred 30 minutes before testing. Technique A and B represent the procedure used for most tests herein reported. For Technique C the quebracho treated suspension was aged at 80° C., for 18 hours before addition of the $CaSO_4$. The $CaSO_4$ was then stirred into the mud for 30 minutes before testing the mud.

Because of the number of variables as well as the complexity of the system being studied most of the work has, of necessity, been restricted to the fixed experimental procedure previously described — namely pretreatment with sodium hydroxide and quebracho and the subsequent contamination with $CaSO_4$. This technique was chosen since it would represent practice in the field wherein a mud is pretreated to withstand contamination with anhydrite. However, it is realized that a true equilibrium is never attained in such colloidal systems. Variation in the order of addition of the reagents, the time between treatments and the temperature and length of the aging period are of importance. Such variables are in reality a part of practice in the field. Results believed to represent the effect of these variables will be presented first along with control experiments showing the effect of $CaSO_4$ and Na_2SO_4 in the absence of any treatment with NaOH and quebracho.

The Effects of $CaSO_4$ and $NaSO_4$ Alone

Table 1 illustrates the effect of $CaSO_4$ in the absence of the quebracho treatment. As little as 0.25 lb. $CaSO_4$/barrel in this system results in a high gel strength mud which would be unsatisfactory for drilling operations. With increase in $CaSO_4$ to 0.5 pounds per barrel the viscosity and gel strengths increase to a maximum. However, for such low concentrations of anhydrite the water-loss remains essentially unaffected. For $CaSO_4$ in the range of one to five pounds per barrel the viscosity and gel strengths are reduced and nearly independent of the $CaSO_4$ concentration while the water-loss increases to a maximum of about 38 milliliter when the $CaSO_4$ is present in amounts of two pounds per barrel.

Considering the fact that for high gel strength muds the physical properties are not highly reproducible, the effect of aging the muds contaminated with $CaSO_4$ can be considered negligible. However, the control test shows that aging the untreated suspension produces an increase in viscosity and gel strength. Such an effect was not obtained with the bentonite suspension previously described[2], and the reason why some batches of this clay behave differently in this respect is not known.

The results for the analysis of the filtrates from aged muds illustrate the effect of base exchange by the clay with the $CaSO_4$. These results show

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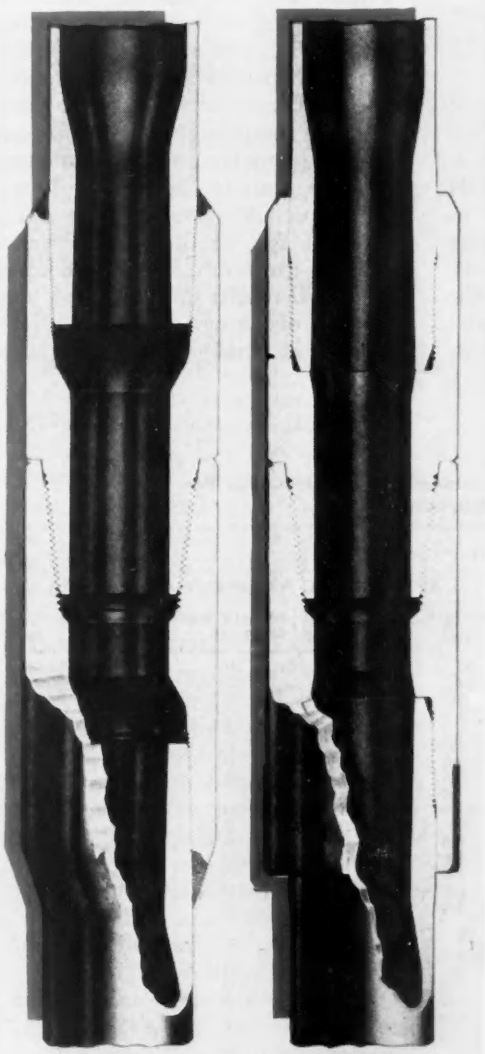

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that for small additions of $CaSO_4$ the calcium in the filtrate remains constant. The $SO_4^{=}$ in the filtrate increases linearly, within experimental error, with increase in amount of $CaSO_4$ until a maximum value of 3500 parts per million is reached. Graphs of these data show that the aqueous phase of the mud is not saturated with $CaSO_4$ until about 1.25 pounds per barrel has been added. In pure water at 25 C a saturated solution of $CaSO_4$ contains 0.74 pounds per barrel corresponding to 620 parts per million Ca^{++} and 2100 parts per million $SO_4^{=}$ whereas for this clay system the Ca^{++} is 540 parts per million and the $SO_4^{=}$ is 3500 parts per million when saturated with $CaSO_4$.

These facts may be explained by considering the bentonite as a sodium (or a mixed sodium and calcium) clay. By base exchange the $CaSO_4$ reacts with the clay as follows:

$$CaSO_4 + Na_2\text{-clay} \rightarrow Ca\text{-clay} + Na_2SO_4$$

For increments of $CaSO_4$ to 0.25 pounds per barrel this reaction proceeds essentially to completion. As more $CaSO_4$ is added, more sodium is exchanged for calcium. Finally some definite, but unknown, equilibrium is reached between the ratio of sodium to calcium associated with exchange positions on the clay, and the aqueous phase become saturated with $CaSO_4$. The fact that the Ca^{++} in the aqueous phase of the mud remains less than that in a pure water saturated with $CaSO_4$ can be attributed to repression of the solubility of $CaSO_4$ by Na_2SO_4 (of Figure 9).

As will be emphasized later, sodium sulfate is present in high-pH muds which have been contaminated with anhydrite. Part B of Table 1 is included to show the difference in effects produced by $CaSO_4$ and Na_2SO_4 in the absence of quebracho treatment. Since a viscous system is produced by small quantities of either salt the high viscosities and gel strengths can be attributed to the sulfate ion. However, sodium sulfate in amounts to ten pounds per barrel does not increase the water-loss value. This fact suggests that the water-loss value is highly dependent upon the relative amounts of sodium and calcium on the clay. The calcium clays form a more permeable filter cake than do sodium clays.

The Effect of Change in the Length and Temperature of Aging the Quebracho Treated Mud Before Contamination with $CaSO_4$

The results presented in Table 2 compare the physical properties achieved by addition of the $CaSO_4$ 15 minutes after treating with NaOH and quebracho (Technique A) as contrasted with addition after aging the alkaline quebracho mud at 80° C. for 18 hours (Technique C). By the former procedure, which has been practiced with most laboratory tests and those to be presented in more detail in another section of this report, the viscosity and gel strengths frequently exhibit marked changes upon aging. This is shown by comparison of results by techniques A and B. This change upon aging is minimized if the $CaSO_4$ is added to the alkaline-quebracho mud which has aged at 80° C. for 18 hours. These tests illustrate why for field practice it is preferable to pretreat the mud with NaOH and quebracho several hours before anhydrite is anticipated. These and other tests also emphasize why a detailed knowledge of the effect of time and temperature of aging is required for the proper interpretation of pilot tests. For such pilot tests the technique usually approximates that of Technique A.

The Effect of Time and Temperature of Aging Upon the Physical Properties of an Anhydrite Contaminated Mud

Figure 1 illustrates the effect of time of aging at room temperature (about 25° C.) or at 80° C. upon the physical properties and filtrate analysis of the bentonite system pretreated with two pounds NaOH and one pound quebracho and contaminated with two pounds $CaSO_4$ per barrel (Technique A). During the aging period at 25° or 80° C. the muds remained quiescent. These and other unreported results show that the temperature of aging markedly affects the rate of change of the physical

TABLE 3

The Physical Properties of the 30 CPE Bentonite Suspension Containing 2 to 10 Lb. $CaSO_4$ Per Barrel and Post-Treated with NaOH and Quebracho[a]

			API CODE 29 PHYSICAL PROPERTIES									
			BEFORE AGING					AFTER AGING AT 80° C. FOR 18 HOURS				
$CaSO_4$, Lb./Bbl.	NaOH, Lb./Bbl.	Quebracho, Lb./Bbl.	Viscosity, cp/E	Initial Gel Strength, g.	10-Min. Gel Strength, g.	Water-Loss, ml/30-Min.	pH	Viscosity, cp/E	Initial Gel Strength, g.	10-Min. Gel Strength, g.	Water-Loss, ml/30-Min.	pH
2	0.25	1	19	0	3	30	9.6	40	10	10	42	8.6
2	0.50	1	12	0	2	39	10.85	34	10	13	40	8.9
2	1.0	1	8.5	0	5	....	12.1	5.5	0	0	34	11.3
2	1.5	1	12	0	0	45	12.45	4.5	0	0	33	11.9
2	2.0	1	10	0	0	36	12.7	5.0	0	0	32	12.45
2	3.0	1	5	0	2	32	12.8	4.0	0	0	25	12.7
2	4.0	1	9	0	3	30	13.0	5.5	0	0	24	12.9
2	6.0	1	6	0	0	33	13.15	5.5	0	0	30	13.15
3	0.5	1	19	4	5	37	9.2	37	10	10	44	8.5
3	1.0	1	7.5	0	4	45	11.9	16	0	2	41	10.7
3	1.5	1	10	0	2	50	12.3	6.0	0	0	46	11.8
3	2.0	1	15	5	5	46	12.45	6.0	0	0	48	12.1
3	3.0	1	5.5	0	0	45	12.65	4.5	0	0	43	12.55
3	4.0	1	5.0	0	0	35	12.8	5.0	0	0	42	12.75
3	6.0	1	5.0	0	2	43	12.95	4.0	0	0	34	12.95
5	0.5	1	5.5	0	0	46	10.5	36	15	12	46	8.45
5	1.0	1	5.5	0	1	54	11.85	31	2	2	45	10.0
5	1.5	1	8.0	0	2	54	12.2	5	0	0	49	11.7
5	2.0	1	8.0	2	4	....	12.35	7.5	0	0	50	12.0
5	3.0	1	10	5	3	51	12.5	5.0	0	0	59	12.2
5	4.0	1	9.0	0	2	59	12.6	4.5	0	0	68	12.4
5	6.0	1	6.0	0	0	64	12.9	4.5	0	0	65	12.7
10	0.5	1	4.0	0	0	39	10.3	34	10	10	44	8.45
10	1.0	1	7.0	0	1	51	11.95	23	0	4	42	10.1
10	2.0	1	6.0	0	0	53	12.4	5	0	0	52	12.1
10	3.0	1	10	0	2	58	12.6	10	5	5	71	12.35
10	4.0	1	9	2	4	59	12.65	6	0	2	75	12.45
10	6.0	1	11	2	2	74	12.75	12	5	3	ca 127	12.5

(a) The $CaSO_4$ was stirred into the mud for 15 minutes. The NaOH and quebracho were then added simultaneously and the stirring continued for 30 minutes.

properties. This may be attributed, for example, to the effect of temperature on the rate of reaction between the free hydroxide and the calcium sulfate to form calcium hydroxide, on the reaction between the clay and hydroxide to form silicates and aluminates, and the reaction of Ca^{++} in alkaline solution with silica, silicates and aluminates. Some of these effects are clearly illustrated in Figure 1. For example, the sulfate in the filtrate of the mud does not reach a maximum until after 50 hours aging at 25° C. as contrasted with the 14-hour period required at 80° C. The initially rapid decrease in the OH^- can be attributed to reaction with the clay and also to precipitation with calcium to form calcium hydroxide.

These results indicate that for the mud aged at 80° C. the physical properties attained after about 18 hours aging may be considered representative of that achieved upon more prolonged aging. While this may not always be true, the trend achieved during such an aging period should give an indication of what may be expected under field conditions.

The Effect of Treatment with NaOH and Quebracho After Contamination with $CaSO_4$

The results thus far presented illustrate the magnitude of the effect of $CaSO_4$ due to variations in the time or temperature of aging the mud pretreated with NaOH and quebracho. These and other results, together with results of more detailed tests show that the general character of the effect of pH and concentration of quebracho or $CaSO_4$ is not altered by such variations. Contrasted with this, treatment with NaOH and quebracho after contamination with $CaSO_4$ produces a considerable difference in the results.

The effect of adding quebracho in amounts of one pound per barrel with variable NaOH to the bentonite suspension 15 minutes after contamination with 2 to 10 pounds $CaSO_4$ per barrel is shown in Table 3. Comparision of these results with those obtained by pretreatment with quebracho is very striking. Post-treatment with NaOH and quebracho, as shown in Table 3, results in a system having viscosities and gel strengths appreciably lower than by pretreatment. For muds having a pH greater than about 11, the viscosity and gel strengths are comparatively insensitive to concentration of $CaSO_4$ in the range of 2-10 pounds per barrel. The results of Table 3 when compared with those of Table 1 showing the effect of $CaSO_4$ alone also show that the effectiveness of the quebracho treatment for water-loss control is eliminated by post-treatment. Limited data with higher concentrations of quebracho show that increasing the quebracho concentration decreases the water loss. For example, with two pounds $CaSO_4$ per barrel the water-loss may be decreased from about 30 to about 15 milliliter by increase in quebracho concentration from one to three pounds per barrel.

Differences in physical properties of clay suspensions attributable to change in order of addition of reagents has been recognized for many years and may explain several phenomena. For example, they suggest that the ratio of calcium (or other polyvalent ions) to sodium (or other monovalent ions) in any given clay may account for marked differences in response to treatment with quebracho. However very little fundamental work has been done to explain such effects. In the present case, it may be that when the calcium salt is added first so that calcium occupies most of the exchange positions within the lattice network of the bentonite, the calcium bentonite is converted by treatment with NaOH into a "non swelling" type of clay by precipitation of $Ca(OH)_2$ within the lattice

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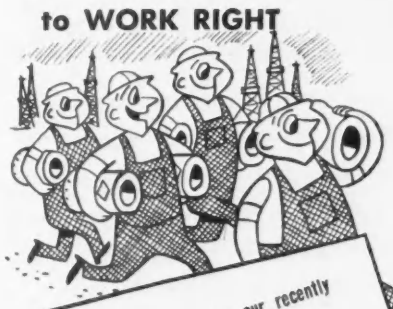

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network. When the Ca salt is added after the NaOH the $Ca(OH)_2$ would be precipitated in the aqueous phase of the mud. Such an explanation is supported, for example, by the work of Kayser and Block.[10] By treatment of sodium bentonite with $AgNO_3$ followed by NaCl, they found that the silver could not be extracted unless the silicate structure were destroyed. If the $AgNO_3$ was added after the NaCl that was not the case.

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(This is the first of two parts.)

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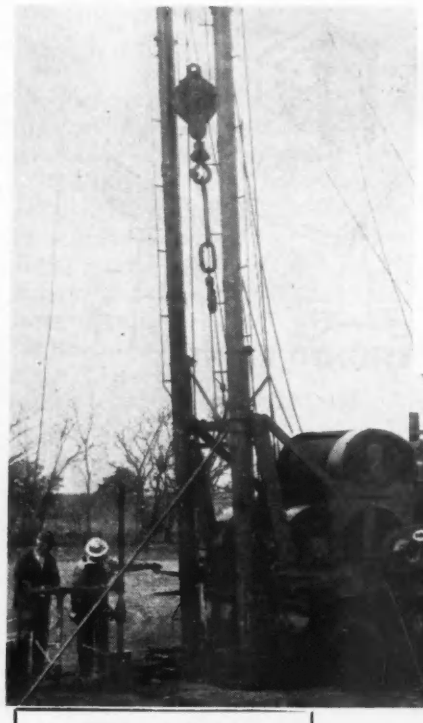

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Diesel Maintenance

■ CONTINUED FROM PAGE 168

erator, lights, cranking motor, battery and controls. Tighten and clean connections.

- ☐ Check air and vapor line connections. Clean and tighten.
- ☐ Check thermal controls.
- ☐ Check soluble oil and anti-freeze solution and add as needed.
- ☐ Clean crankcase breather, air cleaners and pre-cleaners. Add oil to cleaner cups.
- ☐ Fill fuel tanks.
- ☐ Complete lubrication of engine. Change all fuel and lube filters.
- ☐ Adjust valves and injectors.
- ☐ Record oil pressure at 160° water temperature:
  At idling speed_____psi.
  At governed speed_____psi.
- ☐ Road test the engine.
  Estimated time: 23.8 hours;
  Crew time (3 men), 7.9 hours.

"G" CHECK FORM—Preventive maintenance operations. Perform each 32,000 gallons fuel consumed, or equivalent mileage or hour interval.

- ☐ Remove engine from chassis and replace with completely rebuilt engine.
- ☐ Road test rebuilt engine.
  Estimated time; 35 hours.
  Crew time (3 men); 11.7 hours.

Recommendation for Owners

It is recommended that the diesel owner study his operations and convert the fuel gallon charts to mileage or hourly intervals. For instance, if the average fuel consumption for a truck in its operation is one gallon for five miles, the "500 gallons fuel consumed" shown on the check lists would be changed to 2500 truck miles. In fixed equipment where five gallons of fuel is used each hour, the periods would be 100 hours of operation.

The figures for good maintenance and period maintenance charts are based on a complete engine service period of 32,000 gallons of fuel consumption before it must be completely overhauled. That is 150,000 to 225,000 truck miles, or 6000 to 10,000 hours on fixed equipment. Maintenance figures should be on a daily basis with other progressive checks at each 500 gallons of fuel consumed.

All maintenance operations, with the exception of general overhaul operation, can be performed by the average maintenance crew in periods varying from 12 minutes to four hours each. To be entirely effective, the entire equipment must be serviced on the same periodic schedule.

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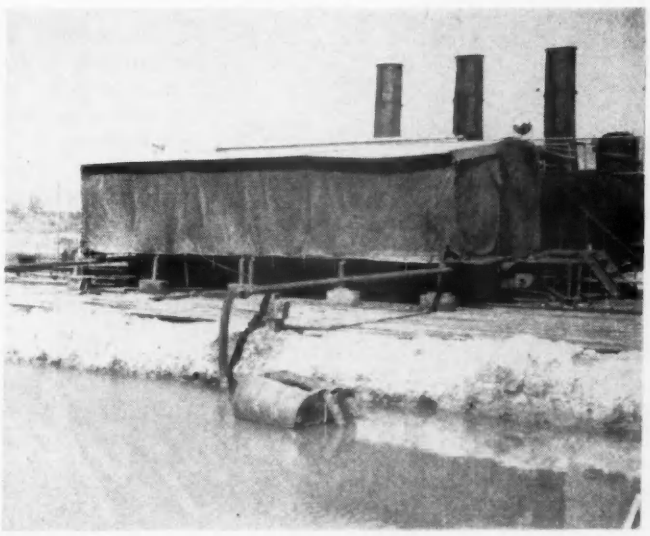
Two-Drum Bobber Keeps Suction Level Constant

A certain amount of sand and mud is probably contained in the water and may get into the boiler feed pumps, where the well is near the pit used to store feedwater for the boilers and the rig.



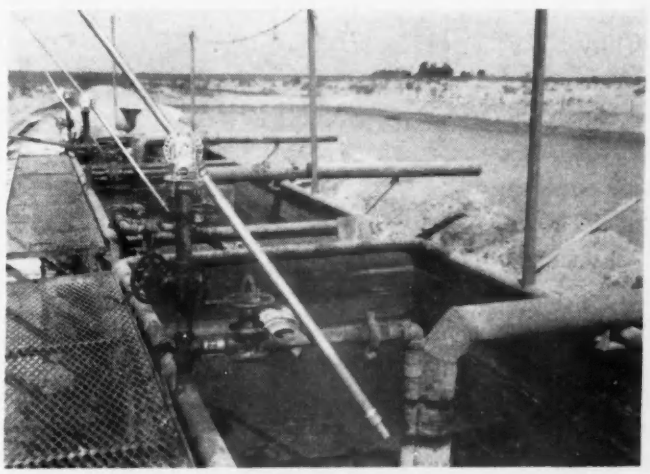
To obtain the clearest water for the boilers the water well inlet to the pit is placed as far as possible from the boiler intake lines to allow sand to settle between the outlet from the well and the inlet to the boilers. The inlet lines to the feed pumps are connected to hoses which rest on top of oil drums and hang just a few inches below the top of the water.

Two drums are used for each hose connection to maintain a constant level. After making sure that the drums are tight and perfectly clean so that they can be welded, they are anchored together at top and bottom with four pieces of two-inch strap iron. The plugs are then screwed in tightly and the hoses are run through the straps and adjusted so that they are just a few inches below the surface of the water.

The hose fits tightly enough that it does not have to be tied, but loosely enough to permit adjustment. This provides a constant supply of clear water for the boilers.

Prefabricated Lines Provide Full Flexibility

Flexibility, system efficiency, and rig-up advantages can be gained from prefabricated lines on mud tanks. The illustrated unit is rigged with the line from the mixing pump connected to a riser, and flanged to a line running along the top of all tanks, positioned between adjacent tanks. The line connected to the top rim of the mud tank provides additional rigidity and extensive lighting facilities are anchored to collars welded atop the line.



Connections are made on top of the mud line in the center of each compartment of the tanks and a riser and tee are fitted into the connection. The top of the tee houses the mud gun stand and the side outlet is connected to a union which junctions with the bottom of the jetting line. This allows the same line to be used for jetting or mixing mud.

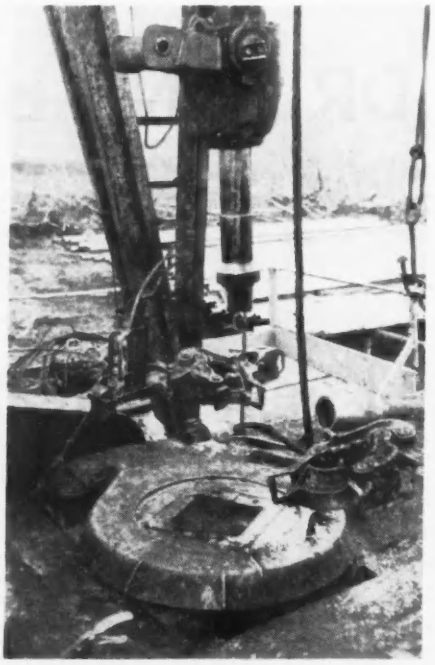
On steam rigs, a steam connection is placed on the line at a point nearest a steam supply and a simple switch of valves will introduce steam or mud for gunning or jetting. On power rigs, high pressure water can be supplied from the pump normally used for mud mixing.

The jet lines are welded in place except for the nipples which extend out into the reserve pit. A union is stationed right at the edge of the tanks to nipple-up the jet lines and a brace is welded in place to support the jet pipe. When the rig is dismantled, the unions are parted and the jet lines swing back inside the tanks.

Bucket Heater Warms Lubricant in Swivel

The work involved in rigging-up during the extremely cold weather often experienced during the winter in northern Canada sometimes is complicated by the congealing and failure of lubricating oils and greases used in the equipment. It is desirable to partially thaw out the lubricant in the swivel while rigging-up, preparatory to attaching the kelly and spudding in on a new hole.

The crews of one contractor's rig in the region employ the simple, yet practical, expedient of lowering the swivel to within a few feet of the rotary table and placing in the master bushing a large bucket partially filled with burning wood or coal. Using a conventional bail-equipped, tapered side bucket, or any other suitable container that will remain seated in the table, the coals can be replenished as necessary and the heating done while work is progressing on other parts of the rig.

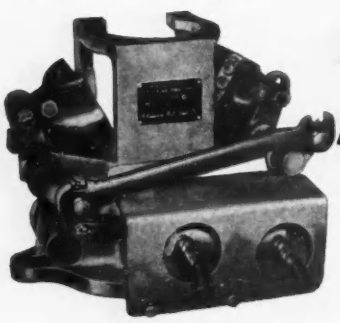


Heat from the coals travels directly upward to surround the swivel and it takes comparatively little time to warm up the lubricant to the point where it is safe to start drilling. The heating operation also warms up the table lubricant and bearings, thus reducing chances of a lubrication failure in the unit when drilling operations commence.

Excess Catline is Stored on Platform

The excess, unused tail of a catline can be fed through the chimney of a ground level tool house and coiled on an elevated platform to insure its protection from damage. Normally, ground level tool houses do not have heaters and the chimney outlet has been sealed. If the tool house is next to the substructure on the driller's side of the drawworks, it is a simple matter to feed the excess catline tail through the chimney for storage in the tool house.

This procedure may be used to particular advantage when the catline is removed from the derrick. As line is pulled from the blocks, it is transfered through the chimney and into the tool house for a rig move.



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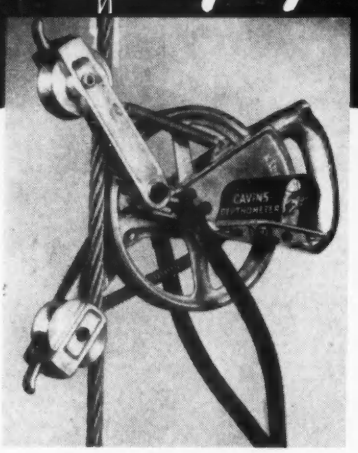

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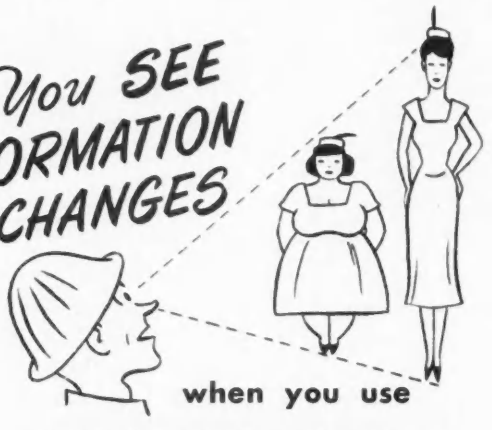
To adjust the height of the line, merely operate the winch, which will easily raise or lower the line.



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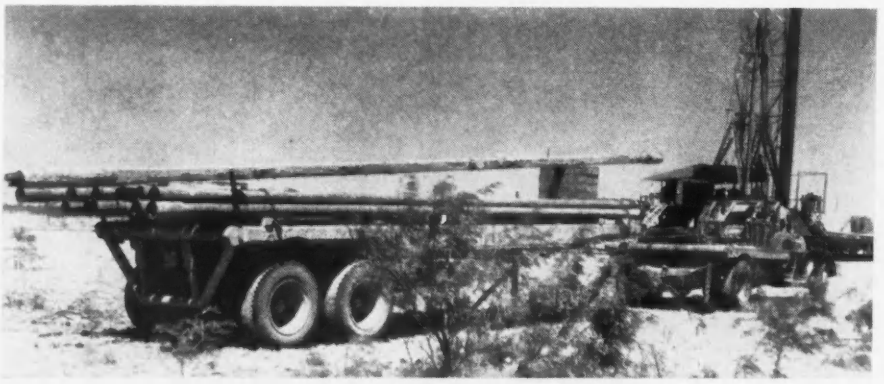
Block Keeps Load Within Road Limits



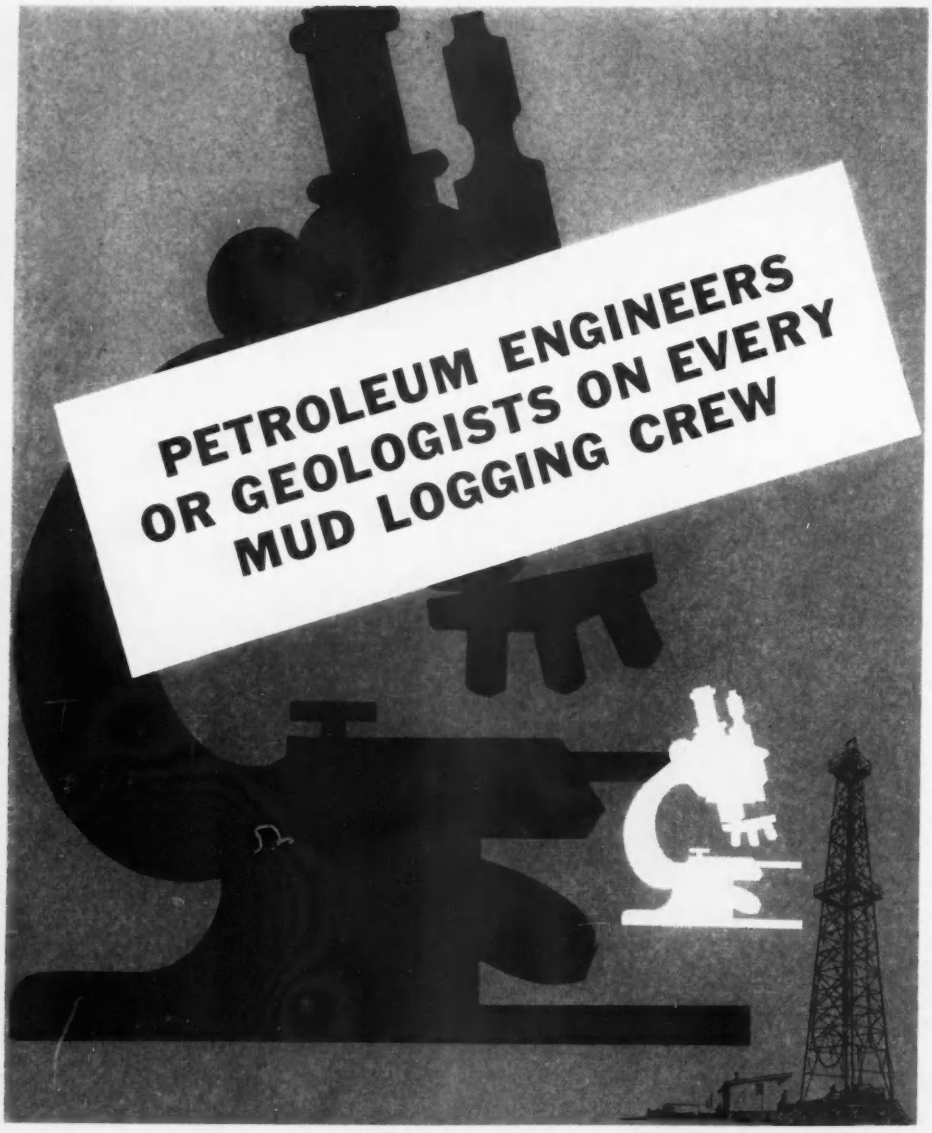
The kelly joint, being ten feet longer than drill pipe joints, poses a problem in moving because a special road permit must be obtained to keep the load within highway restrictions. One company simply keeps a block, made from four 6x10-inch timbers strapped together, with the kelly joint on the rig. When it is necessary to move the drill pipe and kelly joint, the block is placed on top of the drill pipe and the kelly joint is laid on top of the block. This allows the kelly to extend over the truck cab and maintain the load within limits.

In the illustration, the truck has loaded the drill pipe and kelly joint on the trailer and after lowering the booms, is backing under the load with the winch line connected to the float. When the truck is back in place the kelly will extend over the top of the cab to make a much safer load within the highway restrictions.

Hot Water Bypass Safeguards Boiler

The average drilling tools operator rigs the boiler system with a cold water bypass to permit more flexible operation of the steam generating plant. Though a convenience for the fireman, the practice is probably responsible for more serious boiler accidents than any other one thing. The natural tendency for the fireman is to throw cold water into a boiler to cool the unit for cleaning. By the same token, the fireman may accidentally feed cold water to a hot, dry boiler. In either case, serious damage is likely to result in the form of a dropped crown sheet or a blown-up boiler.

To safeguard against these or other potential hazards resulting from the introduction of cold water into a boiler, an operator rigged his steam generating system with hot water only. In this manner, he has found that boiler damage, though not in the form of avoided blow-ups, has been reduced to a surprising degree. With the plan in force, the fireman is not tempted to flush a hot boiler with cold water to assure rapid cooling before washing.



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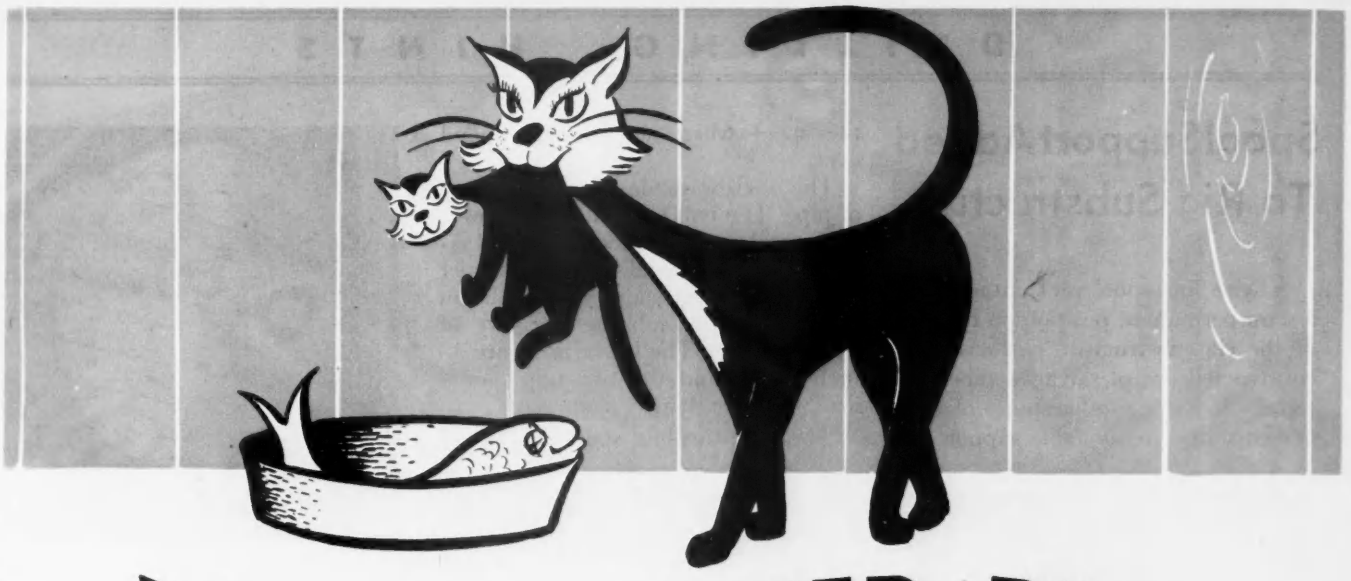

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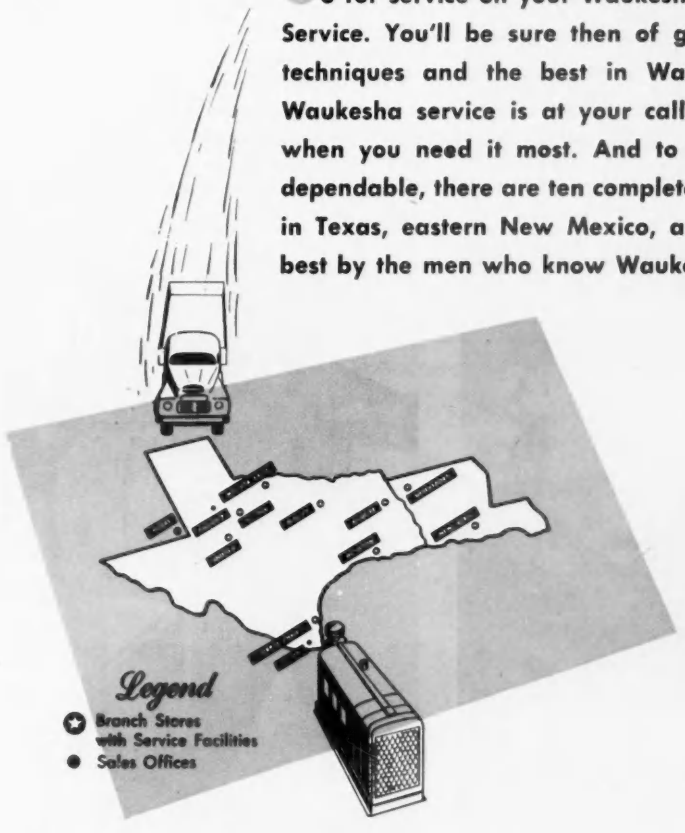

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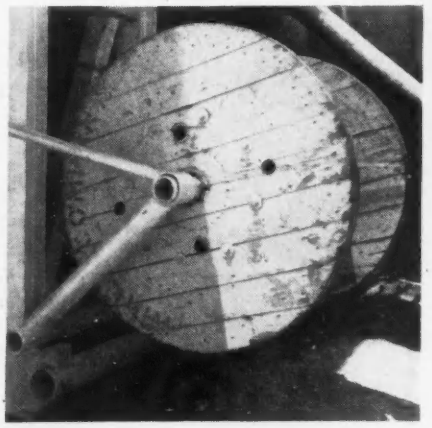
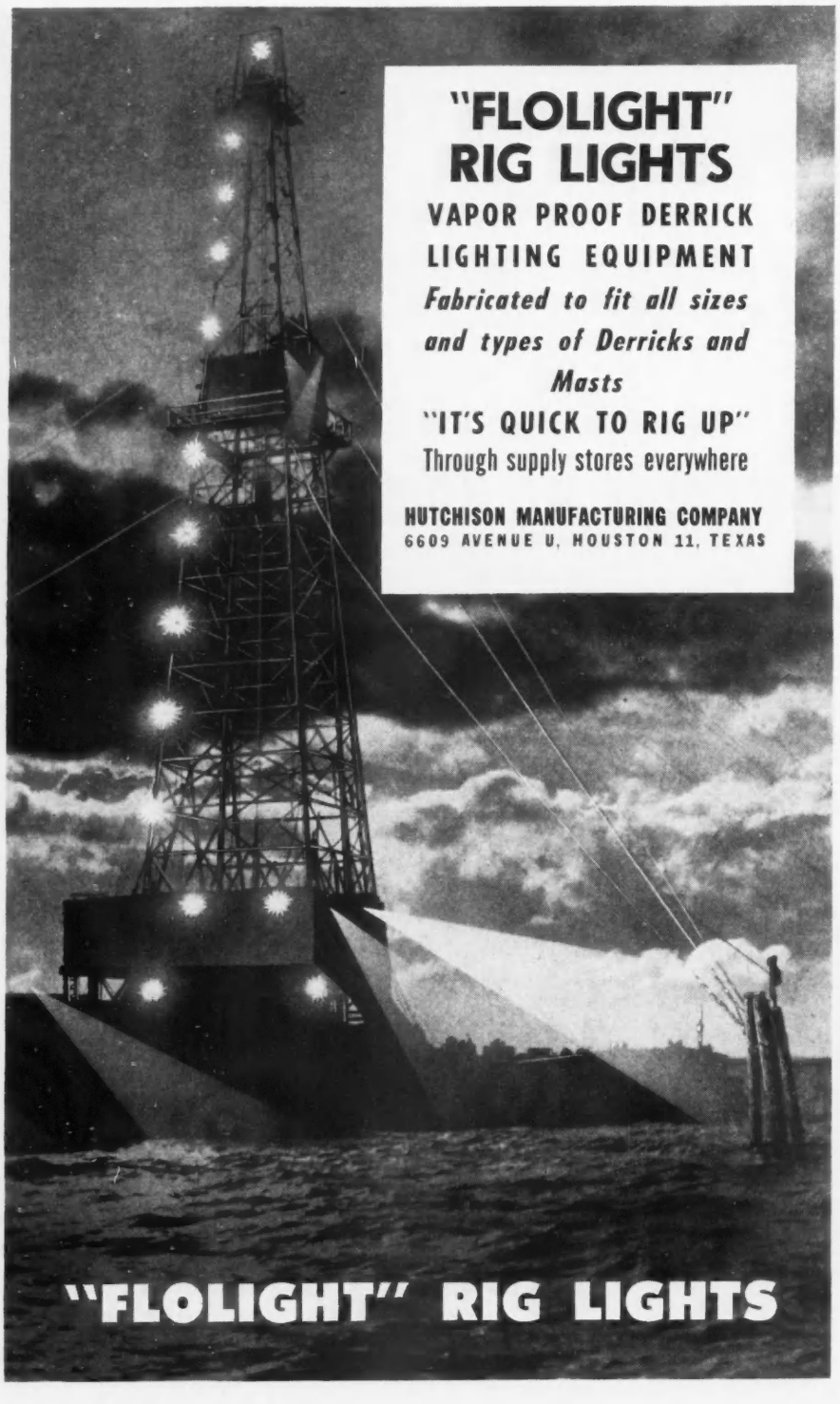
A wire line spool rack attached in a semi-permanent position on the side of the rig substructure can easily be constructed out of salvaged pipe materials. It has the advantages of convenience and more stable support for the spool when new line is pulled over.

The rack is made up of two sizes of pipe. The two lower legs and lower horizontal cross members are of 4½-inch drill pipe and the two upper arms, which are welded to the I-beam columns of the substructure, are of 2½-inch pipe. The lower arms are 40 inches long and the two upper ones are 38 inches long.

The free-turning spool is up off the ground at all times and, being attached to the rig adjacent to the pipe ramp, is out of the way of other operations taking place in the yard surrounding the rig.

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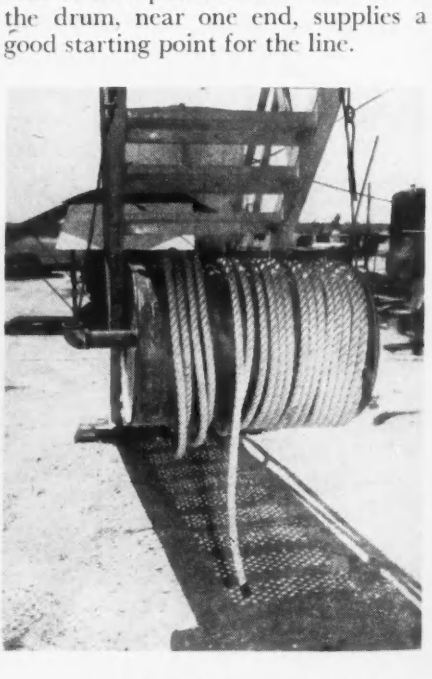
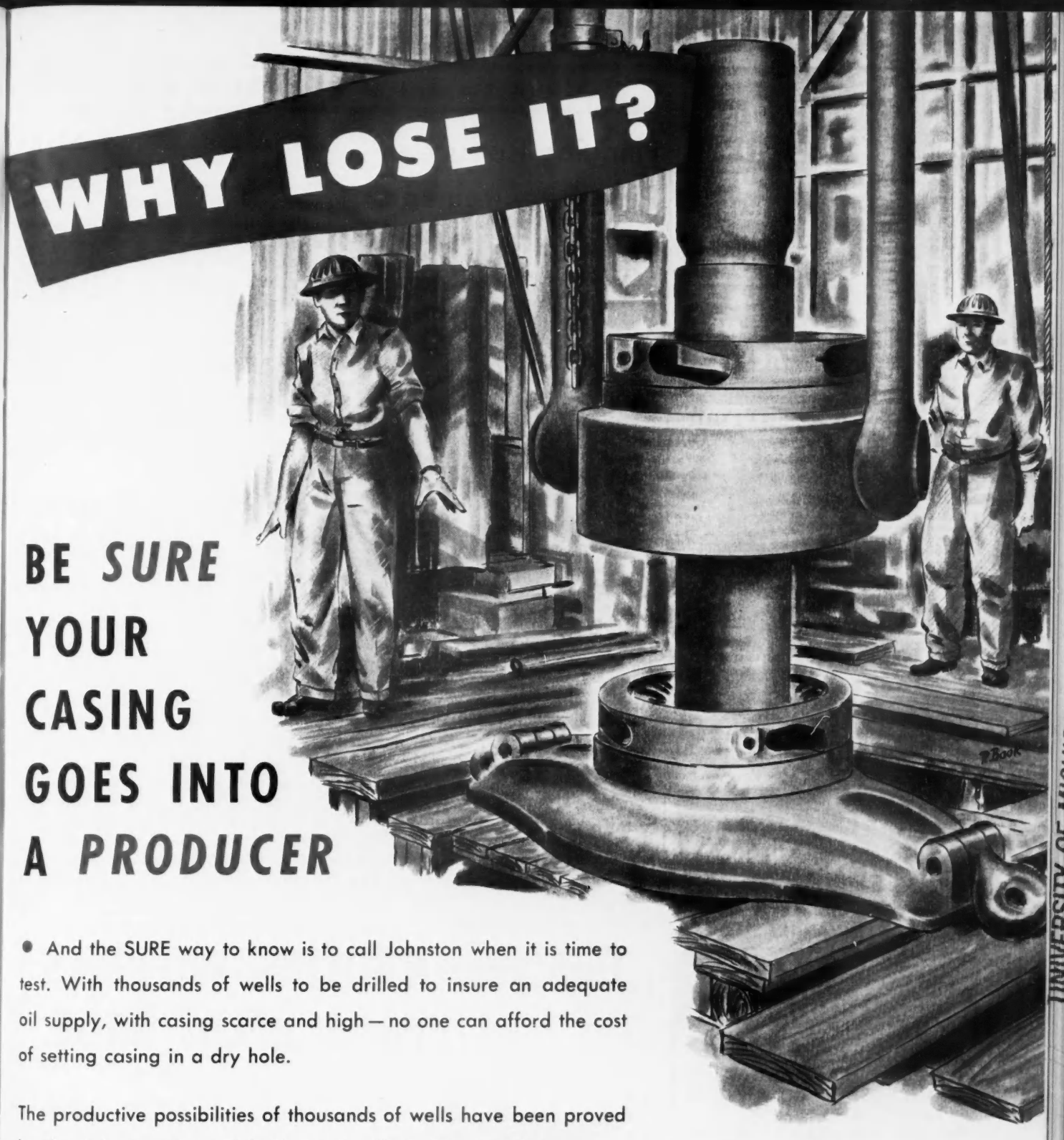
A practical method of storing a spare cat line where it is out of the way of regular traffic, yet is readily available whenever needed, is shown. A 55-gallon drum, punctured at both ends and provided with a two-inch pipe axle, is suspended beneath the ladder going up to the dog house. A length of sand line, run through the pipe axle, is lashed to the under side of the ladder.

The drum provides an ideal place for a man to measure out, cut, bind the ends, then store a replacement line. A hole punched into the side of the drum, near one end, supplies a good starting point for the line.





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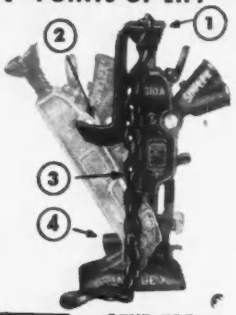

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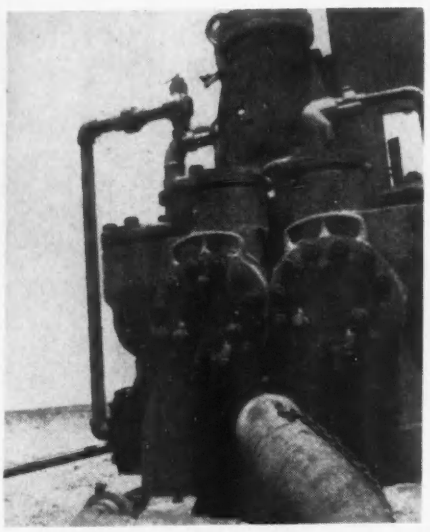
DRILLING HINTS

Flanging Reduces Pipe Requirements



Flanging the mud pump relief line into the base chamber will eliminate the necessity of extending a discharge line from the pump to the mud pit. Application of this idea will reduce the piping requirements when rigging mud pumps for field service.

The installation includes making up a short two-inch nipple in the connection immediately below the air chamber. A high pressure ell, with an all-thread adapter for the relief valve, is then connected to the nipple made up in the pump. From this point, two 2 x 6-inch nipples, divided by a hammer type union, extend horizontally from the relief valve to connect a high pressure ell attached to the two-inch riser. The riser may be cut and threaded to the desired length, or two remnant sections can be welded together to provide the required length of pipe. The riser enters the lower pump chamber by means of a high pressure ell and all-thread nipple, or a heavy duty street ell.

A step toward complete rig unitization, this permanent hook-up will save appreciable time on location to location rigging.

Pipe Wiper Used to Keep Junk From Hole

Worn pipe wipers will block the entrance of tong keys, hand tools, and miscellaneous iron into the hole if installed when running tools back to bottom. The discarded wiper selected should have an opening large enough to permit running the tool joints and, at the same time, small enough to catch objects dropped through the table.

This simple practice will assist in the elimination of locked bit cones or expensive fishing jobs. No additional expense is encountered since the equipment used has been discarded as junk.

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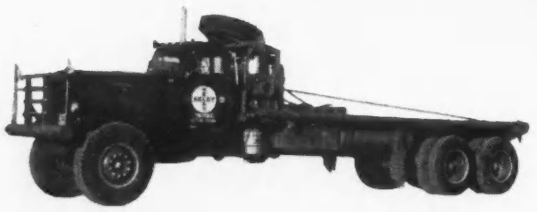

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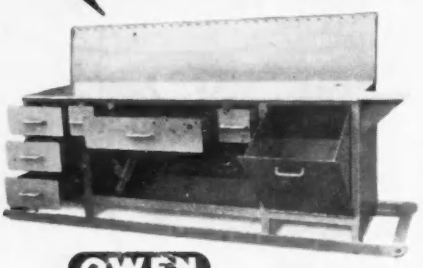

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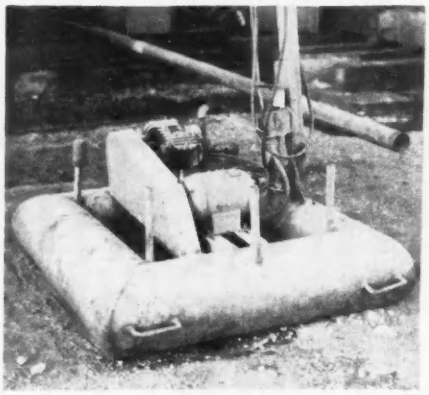
System Furnishes Air for Emergency

A simple, inexpensive electric driven air compressor, resting on a pipe volume tank, will provide the rig with a small supply of air in case of an emergency. Since many critical controls are air actuated, an emergency compressed air supply may be needed to tide a rig over in case of failure. Aside from the requirements of the rig controls, often used air tongs throw an additional demand upon the regular compressor system.

The major construction requirement is fabrication of the pipe air chamber. Any large size pipe can be used for the volume drum, depending upon the job assignments for the standby unit. Each pipe segment is cut an equal length, mitered, and welded together. One-half-inch rod stock tacked on two sides serves as handles. Support for the electric switch box is provided by a three-foot section of two-inch channel iron welded and reinforced by plate steel angles on top of the air chamber.



One-inch pipe verticals attached to the chamber on all sides permit spooling the air supply hose prior to moving.

Two two-inch channel iron spreaders between the ends of the volume drum systems afford adequate reinforcement and support the small compressor and electric motor.

Anchoring bolts for the electric motor are housed in slots which permit spacing the prime mover for the desired tension in the belt drive. A light gauge, sheet steel guard eliminates the possibility of entanglement in the belt and pulley system.

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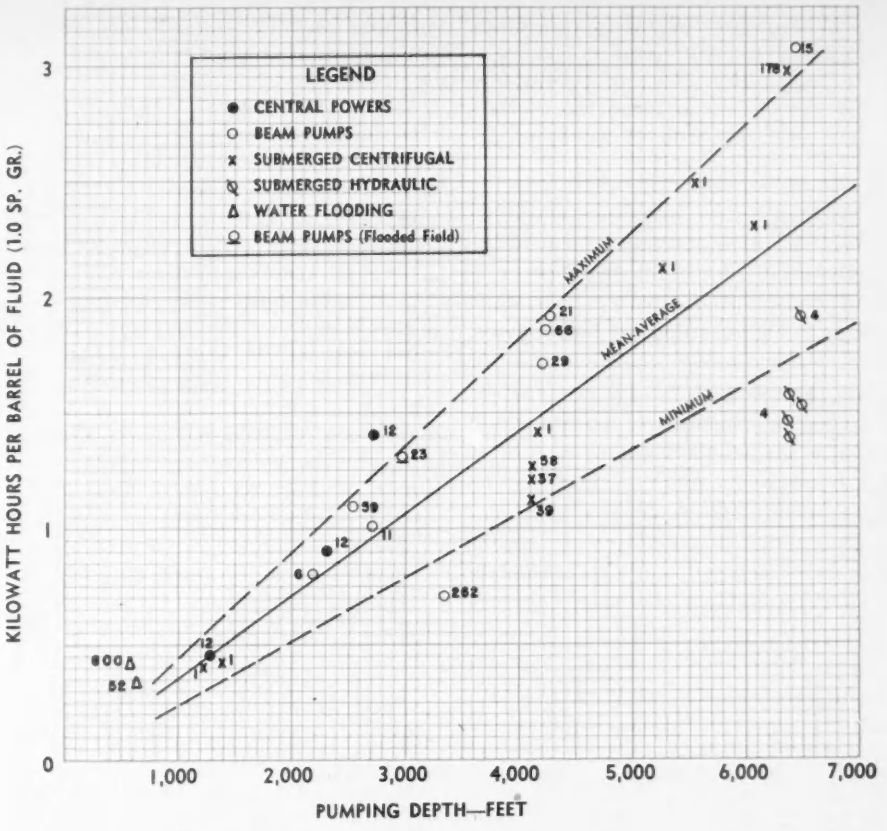
BASIC FACTORS to investigate when first considering electrification of a pumping lease are briefly discussed. The author presents average cost data that can be applied in making a preliminary economic evaluation of electric power. The operator may desire to electrify an old pumping lease, or he may want to electrify pumping wells as they are completed in a new field. Utility lines may be near so that purchased power is available, or it may be necessary to install generating plants. These and other broad considerations are presented as introductory factors in the evaluation of electric power for pumping leases.

By C. R. McNAIR

Engineering Representative
Bethlehem Supply Company, Tulsa



Electric power required to pump oil wells.

Planning Lease Electrification

WHERE economic and operating factors permit electric power in oil well pumping, it offers many advantages such as automatic control, smooth power, good instrumentation for analyzing pumping conditions and lower labor and maintenance costs.

Unfortunately, the operator charged with the responsibility of a lease development program cannot undertake such a project on the mere statement, "It seems to be the best approach." He must first analyze the technical problems peculiar to his lease, and then present his economic case in a manner to produce a sound decision.

During the current period of peak activity, many production men probably would welcome a Do's and Don'ts list whereby they could map their actions according to the rules of experience. Such a list, encompassing all situations that might arise, could fill a volume. For every oil well is different and every lease has its particular requirements when the problem of electrical construction is to be considered. However, it seems reasonable to review the over-all picture to seek a clear and concise approach to the problem.

Two Broad Considerations

There are two general situations which may require original planning. There are the leases requiring pumping units for the first time, and there are the leases now operating with obsolete and expensive equipment. Both situations have essentially the same technical requirements. But the economic considerations are different.

Since the economic study will depend largely upon the plant investment necessary for the operation, estimating of the physical requirements is the logical first step in planning. In the following paragraphs, an attempt will be made to establish some basic factors for a rapid study of the job to ascertain if it is economically feasible to go further into the problem.

The expected production performance of each well must be determined to establish the horsepower requirements for the motors. In estimating the fluid volumes, a conservative figure should be selected which will allow for the worst possible pumping condition. It is less expensive to install ample distribution facilities in the beginning of a project than to remodel later.

Once the volume of fluid to be lifted has been determined, there is a choice of several slightly different approaches in calculating the motor nameplate horsepower to be selected. These methods are at best only close estimates. It is impossible to estimate definitely the subsurface and surface losses. It is just as impossible to say what help will be received from the formation or how long it will last. The following equation for calculating nameplate horsepower is offered as one which has proved conservative in the past without penalizing the operator by indicating equipment too large for the job:

Motor Nameplate HP = 1.9DR

Where D = Depth in thousands of feet
R = Rate of production in hundreds of barrels of fluid per 24-hours

This will rarely indicate a standard motor. So the operator must judge results according to his own case. The most conservative answer is to take the next higher standard horsepower, i.e., 15-horsepower for an answer of 11-horsepower above. However, if he is using a drip-proof motor which usually has a service factor of 1.15, a ten-horsepower motor would not be out of order. When variable load conditions are anticipated and the motor has been selected on an extremely conservative basis, application of a triple-rated motor may even be warranted. Such motors are easy to justify on projects such as a water-flooding development. This is due to power factor and efficiency gains to be realized when operating at near full load. Motor selection will depend on the individual case. The advice of the supplier may be asked before reaching any final conclusion.

Installation Costs

After the pumping units and motors and controls have been selected, it is necessary to consider a means of supplying energy to the equipment. Due to the variations found in labor prices in various sections of the country, it is difficult to lay out any pattern of costs for the various line sections that will be accepted generally. But, for the sake of a ground-laying estimate, a great number of leases have been consolidated as representative of the average conditions to be found, and an average of these leases is offered for consideration as to the installation costs per nameplate horsepower the operator may expect. The leases studied will vary in depth from 2000 to 7000 feet; they will vary in well spacing from 660 to 1320 feet, and they will vary in production rate from stripper wells to the larger fluid volumes produced in the last phases of water-flooding operations.

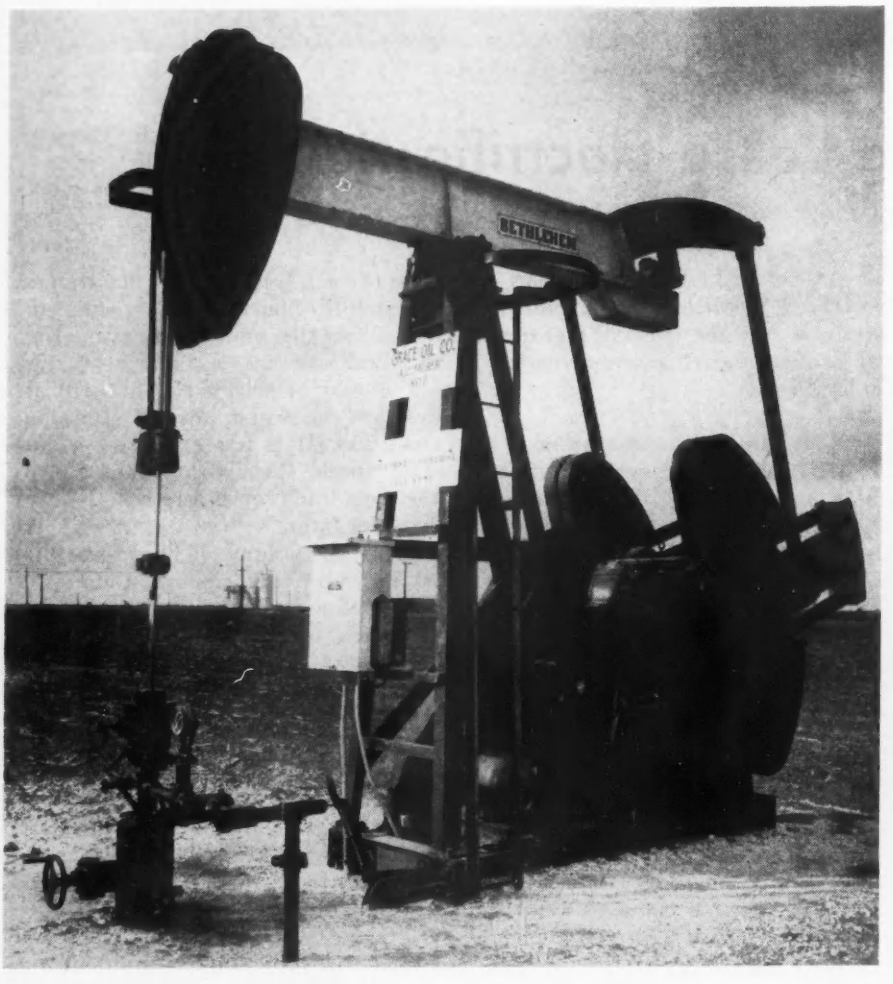
Considering these factors, it was found from a study of about 200 wells and more than 1800 installed nameplate horsepower (1951) that the cost of an electric power system (primary construction, secondary lines, motors and controls) was near $150 per horsepower.

This cost figure will vary in individual cases. Averages must be considered in the planning stage of a development program. The basic planning will establish within a few percent the feasibility of investigating the project in detail Once this fact has been established, the operator will feel free to call in those who will be able to give him exact costs and continue with the job when it is authorized.

To this point, load conditions have been selected and the average system to be required for the job decided. The next problem covers the supply of energy to the lease. In many areas, the geographical location of the lease presents the deciding factor, since utility power may not be available. Such being the case, the planner must estimate the additional investment required for a generating plant. Use of the above formula for the total lease production during a 24-hour period will result in a close approximation of the plant horsepower required.

It will be noted that plant horsepower is approximately the same as the total of the motor horsepower ratings. At first, it seems illogical, for it appears power is supplied at 100 percent efficiency. But the horsepower formula allows for a cyclic load factor in each motor load, and by the time several motors are connected to the source of power, the inherent characteristics of each pumping well will average out into a smoother power supply requirement. Based upon the above calculation of horsepower and upon a generally acceptable oil field generating plant, the average installed investment per horsepower will range from $225 to $275 in a range of sizes running from 30 to 300 horsepower output.

In such instances where purchased power is available near the lease, the operator will want to analyze both sources of energy in his economic study. There is a good "rule-of-thumb" dividing line between the economy of a plant versus purchased power. If the power schedule results in an average cost approaching 1 cent per kilowatt-hour, there may be some question regarding the advantage of operating a plant. But if the energy charges average much higher than 1 cent per kilowatt-hour, a close examination of the economics may be warranted. The basis for a cost analysis of purchased power may be developed using the rate schedule



Typical electrified pumping unit installation near Corpus Christi, Texas, time-clock controlled with motor located under Samson post for compactness.

of the available power and the accompanying curve.

The operator turning to artificial lift for the first time has a relatively easy task ahead of him if his estimate is within practical limits. He can now select a reputable organization to do his engineering and construction and proceed. However, the operator who is working on a modernization program may not find his problems so simple. He can look forward to the worries of salvaging and transferring the present equipment and programming the work so as to lose as little production as possible. There will also be a personnel problem on an old lease of any size, for it is not unusual for a pumper to be responsible for 25 wells on an electrified lease where ten wells would keep him burdened on many properties. Nevertheless, the time, effort and investment necessary to complete a conversion project usually will pay dividends.

Once the operation gets under way, the operator will likely find himself experimenting in an attempt to control the production most advantageously. The rate to be established may depend on proration allowables or it may be distated by the well conditions. In either case some worthwhile time may be spent working out a schedule to produce the oil as cheaply as possible. The groundwork was laid in the original considerations when the units and motors were selected. A third factor could be added, for the size of the equipment will certainly establish the maximum production rate. In any case, the problems are those with which the individual should be familiar and the flexibility provided will aid tremendously in reaching a solution.

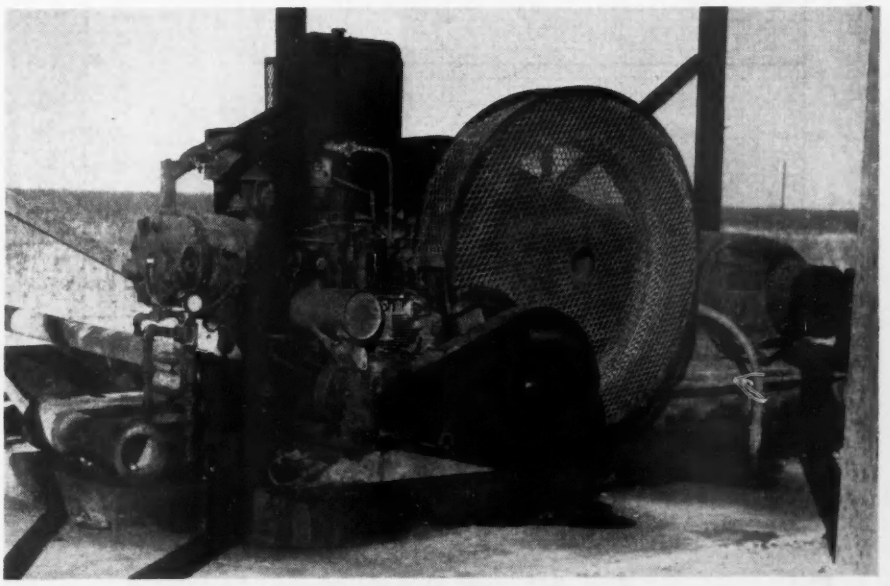
Another important phase must be completed in the early stages if the operation is to be successful. A preventive maintenance program should be worked out in a manner that will fit into company policies. Many organizations have entered the fields to the extent an electrician can be justified in the district. On the other hand, unless the development is sizable, contract maintenance is likely to be less expensive. In either case, the pumpers should be schooled to look for potential trouble. Replacement of a damaged lightning arrestor as soon as it is noticed can save a motor and control during the next storm.

ACKNOWLEDGEMENT

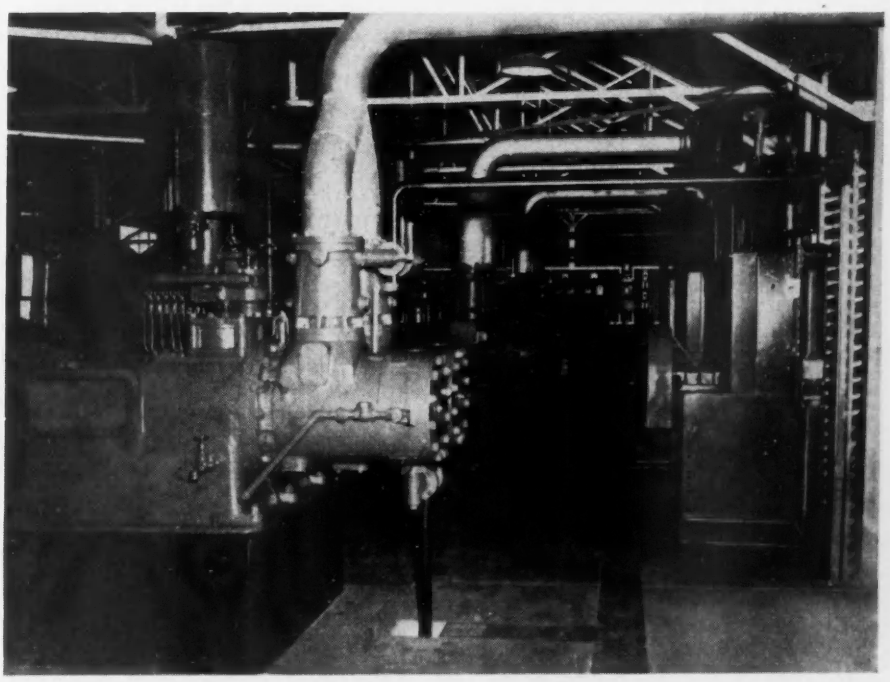
Chart showing electric power required to pump oil wells was redrawn for WORLD OIL from a chart used with the article "The Use of Electric Power in the Petroleum Industry," by W. H. Stueve, published in the April, 1951, issue of **Electrical Engineering.** It appears herein through the courtesy of the American Institute of Electrical Engineers.

About the Author

C. R. McNAIR was graduated from North Carolina State College at Raleigh, N. C., with a degree in electrical engineering in 1947. His first affiliation in the oil industry was with Stanolind Oil and Gas Company at Tulsa in the Manufacturing department. He left that company to join Bethlehem Supply Company in 1948 as engineering representative. He served in the U. S. Army Signal Corps nearly four years. In his present job he specializes in the application of production equipment.



Investment cost is cut to a minimum in the semi-protected engine-generator set shown above, because of simplicity of design. This unit, operating in West Texas, is capable of handling a 30 horsepower load continuously.



Interior view of large generating plant located in the Slaughter pool. It is designed to provide power for 160 wells pumping from 5100 feet.

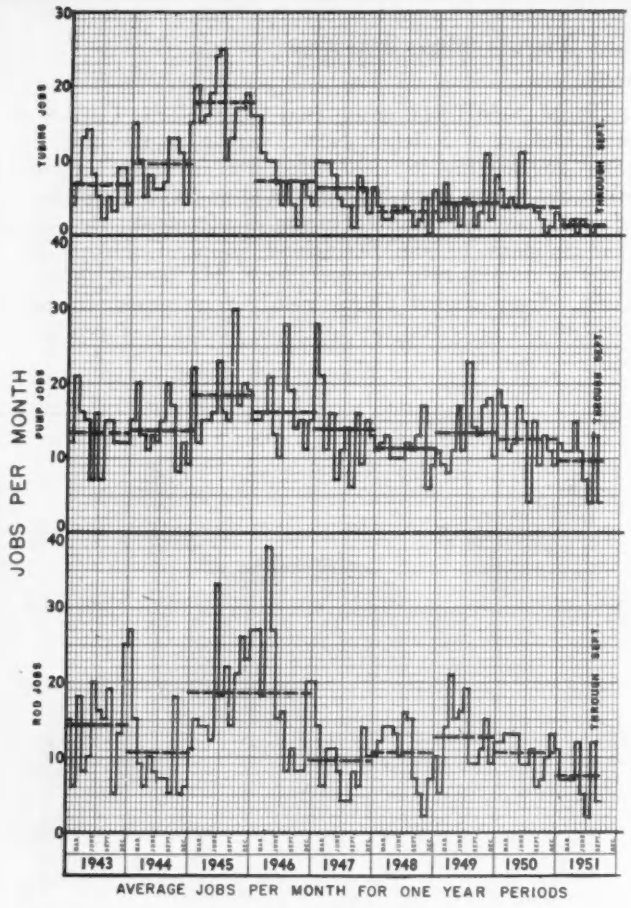


FIGURE 1.

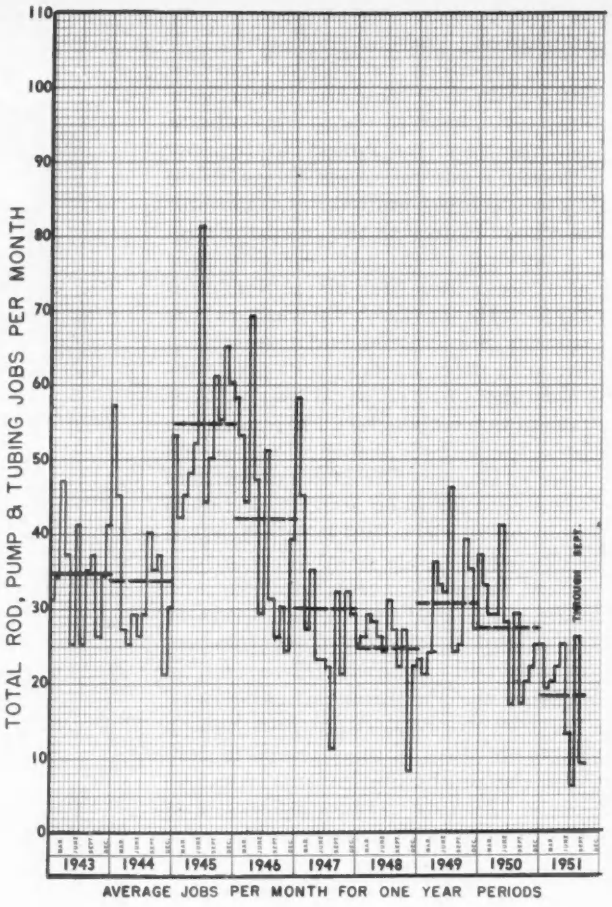


FIGURE 2.

Planned Well Weighing Cuts Operating Costs

By E. R. PHILIPP

The Atlantic Refining Company, Dallas

A "WELL weighing" program puts into action an organized, systematic plan to prevent equipment failure, reduce lifting costs, reduce downtime loss of production, increase production if possible, institute better methods of operation and maintenance, and improve the design and selection of the pumping well equipment.

It also gives the field personnel knowledge of the technical explanations for troubles encountered, so that their cooperation and opinion can be obtained. Of prime importance is the acquisition of complete equipment, production, operation, repair, and cost data on each well so that an accurate, complete and comprehensive analysis can be made when the weighing program has been completed.

Workover jobs, installation of new or partial strings of tubing or rods, and repairs to engines and units are not considered because repair costs are not presently available. Since material and labor constitute the major portion of lifting cost expense for each job, these items, less any salvage, were used to estimate the average cost of a rod, pump, or tubing job.

BENEFICIAL RESULTS obtained when a systematic program of well weighing and complete analyses were applied to troublesome pumping wells are described. The author lists recommendations made for changes in equipment, design, operation, and maintenance which were followed. Although this paper is confined to analyses of the individual rod, pump and tubing jobs on a number of wells in the Kansas area, it may apply to similar problems in the general pumping field.

Analyses of the repair jobs covers a period of 8¾ years (1943 through September, 1951) and the studies indicate that after the well weighing program was put into effect, although repairs continued on an upward trend for a year (1945) or so, they were on a decline thereafter. This decline can be attributed to intensive dynamometer work, complete well analyses, and constant cooperation of the field

ARTIFICIAL LIFT EQUIPMENT
REPAIR REPORT

3B 792—150 Bks.-A-R.-89-425

Date_____ 19__

PROVINCE_____ LEASE_____ WELL NO._____ FIELD_____ COUNTY_____ STATE_____

TYPE OF REPAIR JOB

Rod ☐ Tbg. ☐ Hyd. Pump Tbg. ☐ Subsurf. Pump ☐
Gas Lift Valves ☐ Misc. Surf. Well Equip. ☐

Date of Failure | Date Repaired

Downtime in Days | Depth of Failure

Type of Failure

Cause of Failure

WELL DATA ON DATE OF FAILURE

Date Installed

Days of Service

Strokes/Minute or Choke | Pump Bore-Dia.

Length of Stroke or Intermitting Interval

Depth of Pump or Producing Valve

Total Depth | Top Prod. Int.

Daily Production-Bbls.: Oil | Water

EQUIPMENT CHANGE If any changes were made in type or size of equipment list items replaced & new items installed, give comp. descrip.	MATERIAL Cost of New Equipment	MATERIAL Salvage Value of Equip. Recovered
	$	$
EQUIPMENT REPAIRS OR REPLACEMENTS List items repaired or replaced without change in specifications.		
Total	$	$

COST DATA	COST
Equipment Change & Repair Cost Total (Net)	$
Pulling Unit Cost	
Other Labor & Teaming Cost	
TOTAL COST	$

Signed
Accounting Clerk

Recommendations of Operating Section

Signed

Recommendations of Engineering Section

Signed

Instructions of District Superintendent

Signed

Signed
Production Foreman

Signed
District Material Man

FIGURE 3.

personnel with the test engineer in following his recommendations.

The program was considered successful because the efforts of the test engineer and the field personnel resulted in a decrease of repair jobs each year since a high was reached in 1945. (See Figure 2.) This decrease in repair jobs resulted in a large cash saving, a decrease in downtime and consequently an increase in production. Another result was prevention of incipient trouble or failures, better operating and maintenance methods and better equipment design. The data and experience acquired by the test engineer and field personnel were invaluable in attacking or preventing troubles similar to those encountered.

"Weighing a well" does not mean merely the use of a dynamometer to obtain the load on a well; it means to "weigh all the facts about a well" so that, when all the data have been analyzed, the result is a well-balanced set of recommendations for necessary changes, if any, in the design, selection, operation, and maintenance of the well equipment, which will help solve its immediate past and future problems.

To obtain the desired results, it is essential that the engineer be well-versed in dynamometer work and interpretation of dynamometer cards, and application of engineering principles to pumping wells. The engineer is needed because his technical knowledge and training fit him to answer questions of mass, motion, material, and design. This engineer must be supplied with all the tools, instruments, and equipment necessary for his work.

Another requirement is cooperation of the field personnel who are in daily contact with the pumping wells and can contribute valuable data and suggestions which the test engineer must use in his analyses of the various problems. Without the help of field personnel who actually operate and repair the wells, and record all pertinent data concerning them, (such as their troubles, and what was done to eliminate or reduce these troubles), the test engineer is at a disadvantage. If he must start with a meager history, he may have to make several trips, instead of one or two, before all the troubles have been diagnosed and taken care of. This means that, to carry on an economical and efficient survey in an area, the help and cooperation of field personnel is absolutely essential. The program is of mutual benefit to both the field personnel and the test engineer since both gain experience, data, and knowledge which can be used in attacking future troubles.

Drilling, completion, and production data on a well is usually obtainable from company files. However, repairs, replacements, material and labor costs, salvage, etc., are usually carried for the lease as a whole and not broken down for each well. Individual well data must be used in a

UNIVERSITY OF MICHIGAN

weighing program, and to prevent having to go through innumerable records to tabulate the data for each well, a form designated as "Artificial Lift Equipment Repair Report" was devised to account for all the necessary essential well data concerning each job on each well (see Figure 3). This form is filled in by the field personnel and accounts for all repair jobs.

The test engineer must have complete engineering data concerning well characteristics, operation, production, equipment and methods of operation at the time of each test to analyze conditions and correlate them with his dynamometer work. For this type of data a form consisting of two sheets was made up (see Figures 4 and 5). This form becomes part of his report on each well along with the dynamometer cards and calculations. The form also has space for any recommended changes in operation, design, or equipment, and a space for remarks concerning the well, the troubles encountered, and why certain recommendations were made.

Application of Engineering Principles

When a well has been analyzed and changes have been made, the test engineer usually makes a check of the well to see if the desired results have been obtained and optimum producing conditions exist. The test engineer can and does improve certain features of pumping well operation by the application of fundamental engineering principles. The field man, through training and experience, has acquired knowledge of the techniques and procedures necessary to keep the wells pumping. However, when problems of mass, motion, material, design, reservoir characteristics, and related conditions become complex, he needs the help of the test engineer. The test engineer weighs the well and obtains facts which can be determined in no other way. Dynamometer studies are of tremendous value as a basis for comparison of well conditions before and after changes are made.

The scope of this article is not sufficient to enumerate the multitude of troubles and problems which are a part of pumping well operation, and the means to combat them; that information can be obtained from numerous published papers on the subject of beam pumping. The test engineer makes a study of all these problems and what was done to obtain better and less costly operation and applies this knowledge in his work.

Since physical operating characteristics change with the reservoir characteristics, to obtain maximum efficient operation there must be a well-balanced system from the standpoint of design, maintenance, and care, at all periods during the life of any particular well. The test engineer's job is to approach these correct conditions as closely as possible.

Abuse of pumping well equipment can come from several causes. Foremost is incorrect selection of materials, type, size, rating, and design and operating cycle. Then there are field conditions to contend with, such as corrosion, sand, paraffin, scale, etc. In addition, there are abuses connected with installation, field handling and mechanical operation. All these factors contribute to failures and incorrect operation of pumping well equipment. The test engineer's job is to correct the design and operating conditions so that normal optimum producing and operating conditions will exist and the life of the equipment is prolonged as much as possible.

Economics of Change

In making his studies the test engineer must take into account the economics of making equipment changes. Among the factors he must consider are payout of extensive equipment changes in relation to remaining reserves; whether the present equipment can be used with minor changes; whether production will be increased or decreased; how much salvage is obtainable; whether the changes will take care of future water and oil production, or additional changes will be needed; whether the changes will cost more than the expected future revenue, and abandonment must be considered; whether an-

3B-676 12-49

WELL ANALYSES AND RECOMMENDATIONS
PETROLEUM ENGINEERING SECTION
MECHANICAL ENGINEERING GROUP

Date Tested _____ Date Analyzed _____

Lease _____ Well No. _____ Field _____ County _____ State _____

Producing Horizon _____ Name _____ Depth _____ Total Depth _____ PBD _____

Prorated _____ Allowable _____

PRIME MOVER: _____ Make _____ Type _____ HP _____
RE# _____

No. Cyls. _____ Bore _____ Stroke _____ Displacement _____

RPM At Normal Cycle _____ RPM.
Sheave Size _____

UNIT: _____ Make _____ Type _____ HP _____ Peak Torque _____
RE# _____

Pol. Rod Ld. Class _____ Length of Strokes _____

Type of Foundation _____
Sheave Size _____

CASING: _____ Size _____ Grade _____ Casing Seat _____

TUBING: _____ Size _____ Grade _____ Set At _____

Number of joints _____

POLISHED ROD _____ Make _____ Type _____ Size _____

CALIPERED O.D. OF POLISHED ROD _____
P. R. LINER? Yes _____ No _____
Remark: _____

PRESENT INSTALLATION	RECOMMENDED CHANGES
RODS: _____ Make _____ Type _____	_____ Make _____ Type _____
_____ ft. of 1" _____ ft. of ⅞" _____ ft. of ¾"	_____ ft. of 1" _____ ft. of ⅞" _____ ft. of ¾"
_____ ft. of ⅝" _____ Total Length	_____ ft. of ⅝" _____ Total Length
Endurance limit _____ # in _____	
ANCHOR _____ Type _____ Size _____	Remarks: _____
OTHER ATTACHMENTS: _____	
PUMP _____ Make _____ Type _____ Size _____	_____ Make _____ Type _____ Size _____
Plunger Type _____	Remarks: _____

REPAIR JOBS

Year							Total
Rod							
Pump							
Tubing							
Total							

FLUID LEVELS _____ Date _____ Static _____ Pumping

Remarks: _____

FIGURE 4.

AXELSON

HYDRAULIC LONG STROKE PUMPING UNIT

Three major phases in long stroke pumping offer distinct profit producing advantages to the petroleum operator:

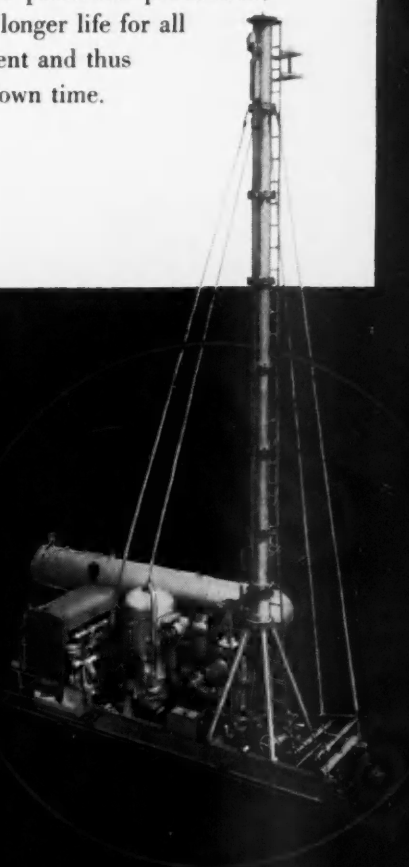
INCREASED STROKE LENGTH means... (a) overcoming stroke loss due to rod and tubing stretch; (b) greater plunger travel provides marked assistance in the handling of gassy fluids; (c) decreasing frictional wear by distributing it over a greater length.

FEWER STROKE CYCLES PER MINUTE means... that all surface and sub surface pumping equipment going through its cycle 5 times per minute will last longer than the same parts doing the same job 15 to 20 times per minute.

COMBINATION OF LONG STROKE AND FEWER STROKE CYCLES PER MINUTE means... (a) that rods can be successfully operated with peak stresses from 20 to 30 per cent over conventional pumping practice; (b) decreased impulse load factor allowing increase in pump size or pump depth; (c) rod string can be lightened due to the greater allowable stress.

While the Axelson long stroke pump is not offered as a cure all for all pumping unit problems, it does have specific applications which assure more profitable production, fewer rod failures, longer life for all subsurface equipment and thus considerably less down time.

AN AXELSON ENGINEER IS AT YOUR SERVICE FOR DISCUSSION OF ANY SPECIFIC PUMPING PROBLEM WHICH YOU MAY HAVE



AXELSON

PETROLEUM PUMPING EQUIPMENT

OUR 60th YEAR

THERE IS NO ECONOMICAL SUBSTITUTE FOR QUALITY

AXELSON MANUFACTURING CO. • 6160 SOUTH BOYLE AVENUE • P. O. BOX NO. 15335, LOS ANGELES 58, CALIFORNIA

other type of lift should be considered; etc.

The foregoing emphasizes the fact that diagnosing well troubles is a complex engineering job not one for a novice. Since the cost of operating pumping wells has continued to rise the past few years, it can be seen that the problem of getting the most oil for the least cost for the longest period of time is one that every company should study continually if economic operation is to be maintained.

It was noted in this survey program that although cost figures were not available on unit and engine repair jobs, such jobs decreased along with rod, pump, and tubing jobs when better design, maintenance, and operating conditions were put into effect.

After making a study of an area, the test engineer determined which were the high cost wells. Since the rod, pump, and tubing jobs constituted the greatest number, the wells which had the highest rate of incidence of such jobs were analyzed first, because they offered the best possibilities for savings in repair costs.

Table 1 shows how the rate of incidence for each type of job progressed from year to year.

In 1949, due to previous damage and stress on old equipment, failures increased somewhat. Many of these failures were retarded for several years through better design, operation, and maintenance practices. Part of the increase in jobs was due also to the practice of pulling rods, pumps, and tubing to inspect them for wear, corrosion, etc., and to prevent future costly repair jobs. Inspection of equipment was part of the over-all survey program and constituted an economic move. These jobs were done to determine damage, if any, wear, and what effect changes in design, operation, maintenance, and treatment had on the equipment. Measures were then taken to replace faulty equipment and help prevent future trouble.

From the available figures, average cost for each type of failure (rod, pump, tubing) was obtained (see Table 2). It is anticipated that in 1951 a new low will be attained in the total number of repair jobs. It is also anticipated that in the future the old stressed, damaged and fatigued equipment will continue to fail, causing a certain number of repair jobs. However, this type of failure will be minimized as the years go by and better operating conditions and design are maintained. Wear which cannot be prevented will be the cause of many replacements and failures. It is estimated that even under the best conditions, after one year of service a pump will start showing signs of reduced production or some mechanical difficulty due to normal wear. It follows that the rate of incidence of pump jobs per year should be 1.0 and that a pump should be pulled once a year to replace worn parts, if any show up during inspection. This preventive work will reduce costly pump jobs which result when a part fails and causes other parts to fail, help maintain production and reduce downtime losses.

Many troubles inherent in pumping wells are detected by use of the dynamometer, which detects change in well conditions. Analyses usually result in corrective measures which reduce detrimental conditions.

Changing well conditions which cause an increase in load will increase the rate of wear. Since normal wear reduces the ability of the equipment to withstand load, abnormal wear due to heavier loads reduces it still more and the failures become more frequent. The well then becomes a high cost well and the equipment is many times tagged as faulty when the actual cause is a change in well conditions. These conditions must be constantly analyzed and preventive measures and correct design applied.

To keep up with these changes the test engineer arranges a schedule whereby he visits an area every six months to a year and surveys the wells indicating trouble. In this way, those wells needing attention are not likely to be passed by until costly repairs show the need for analysis—too late to help reduce repair costs.

Figures 1 and 2 show the results of such scheduled surveys, which were made at approximately one year intervals. The results were encouraging in that in each type of job (rod, pump, tubing) a decline in the number of jobs was noted after 1945, when a high was registered. The surveys started in the first few months of 1944 were made yearly and are being continued.

Figure 2 shows the average jobs per month for each year and the fact that after 1946, the total jobs were still below 1943 and 1944, when a low average was maintained.

Results

The program showed after study that the following results were obtained:

- Reduction in number of jobs since 1945 when the repair costs became excessive and a high was reached.
- A great saving each year since 1945 was obtained by keeping jobs to a minimum.
- Better design and selection of equipment was adopted and put in use.
- Better operating and maintenance practices were put into effect.
- Detrimental conditions were diag-

Well _____

Date Tested _____

PRODUCTION DATA

AVERAGE DAILY PRODUCTION: Oil _____ BPD

Water _____ BPD, Total Fluid _____ BPD

Cycle: _____ SPM _____ Length of Stroke "w/ _____ Plunger Size"

LAST PROD. TEST: Date _____ Hrs. Tested _____

Cycle _____ SPM _____ Length w/ _____ Plunger "S.G. _____ GOR _____

Oil _____ BPD, Water _____ BPD, Tot. Fluid _____ BPD

RECOMMENDED CHANGES

_____ SPM _____ Length of Stroke "w/ _____ Plunger Size"

EXPECTED PRODUCTION:

Oil _____ BPD, Water _____ BPD, Tot. Fluid _____ BPD

Remarks: _____

CALCULATED DATA: Normal Conditions _____ SPM _____ Length of Stroke "w/ _____ Plunger Size"

		Max.	Min.	Range	Rods	Fluid	Static	Drop in Static
Loads	Meas.							
	Theor.							
Peak Torque	Meas.				Counterbalance		Meas.	
	Theor.						Theor.	

Stroke	Polished Rod Stroke—Meas.	Calc. Net Plunger Stroke Prod.	BPD
	Net Plunger Stroke—Calc.	Actual Production _____ BPD	
Volumetric Efficiency: Net Calculated Plunger Stroke _____ %			
Horsepowers	Measured Pol. Rod HP _____	Estimated Average BHP _____	
	Meas. Peak Pol. Rod HP _____	Estimated Peak BHP _____	

GENERAL REMARKS:

Date

Tested By: _____

Analyzed By: _____

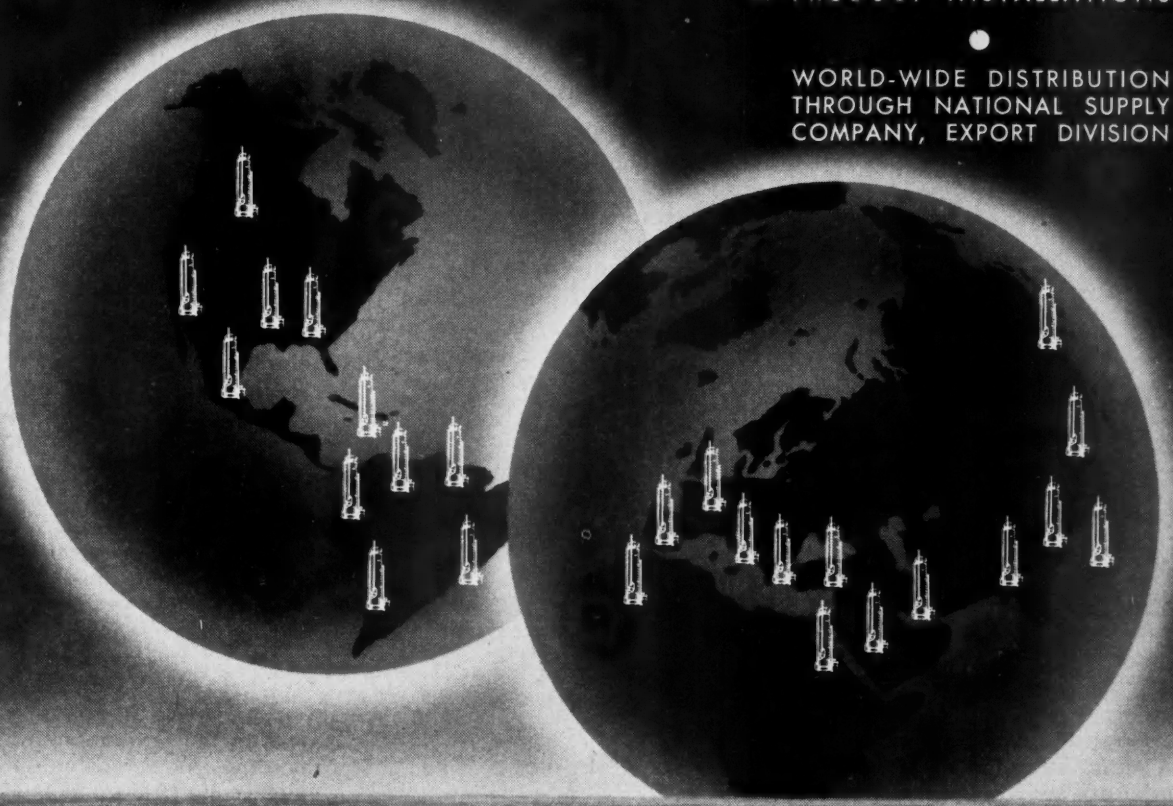
Approved By: _____

FIGURE 5.

National Products...
INTERNATIONAL FAVORITES

NATIONAL TANK COMPANY
PRODUCT INSTALLATIONS

WORLD-WIDE DISTRIBUTION
THROUGH NATIONAL SUPPLY
COMPANY, EXPORT DIVISION



It's a National

NATIONAL TANK COMPANY

TULSA, OKLAHOMA

REGISTER and VOTE—it's YOUR country

nosed, suitable equipment installed, and changes made to prevent repetition of troubles encountered.

- Downtime was reduced and production thereby increased. Volumetric efficiency was also increased by changes in operation or equipment.
- Overall repairs became less costly, decreased in number as corrective measures were applied, and incipient failures were detected in time to prevent more costly jobs.
- Field personnel acquired a technical knowledge of the cause for troubles and the means to combat them.
- A case history of each individual well was obtained and recorded for future use.
- The test engineer obtained a working knowledge of the troublesome wells and the troubles peculiar or common to that area.
- The life of equipment was extended by use of basic engineering principles, and observation of practical rules on care and maintenance in the field, to reduce abuse of equipment.
- Dynamometers in themselves were not sufficient although the data obtained by their use was of extreme importance; they had to be used in conjunction with complete well data in order to arrive at a complete answer to a particular problem.
- This type of work gives the producer the benefit of increased recovery at lower cost, improved equipment design, greater salvage value of equipment when a well is depleted, complete data on the well troubles, characteristics, and operating costs.
- The study, analysis and control of pumping operations resulted in a reduction in lifting cost.

Conclusions

A well-planned dynamometer and well analysis program can be the means by which uneconomical operation can be greatly reduced or eliminated.

About the Author

E. R. PHILIPP joined The Atlantic Refining Company in June, 1929, and has held a number of positions with the organization including geological draftsman, assistant to head of geophysical research, assistant petroleum engineer, engineer in charge of engineering and operating laboratories, and mechanical engineer. At present he is field gas supervisor for his company with headquarters in Dallas.

Well testing and analyses discussed in this article have been extremely valuable in segregating the effects of the variable factors which influence the economics of beam pumping. Knowledge gained in the program has been instrumental in improving the design, selection, operation, production, and maintenance practices in all areas. Such factors as proration, idle equipment, company policy, reservoir characteristics, capacities and ratings of existing equipment, operating methods, maintenance, reserves, repair costs, type of trouble, selection of equipment, and others, must be recorded, considered, and analyzed from an engineering standpoint before optimum producing conditions can be attained.

The increasingly high cost of repairs to pumping well installations demands that a company keep an engineer on the job full time or hire the work done by an engineering firm well versed in pumping well troubles. The cost of preventing and tracking down troubles is only a fraction of what can be saved by reduction or elimination of repairs. From an economical point of view, this planned well-weighing program has paid for itself many times over, great savings in repair costs have been obtained and volumetric efficiencies improved.

Oil well pumping equipment is subjected to loading rarely found in any other industry. The loads and torque can vary from zero, or even a negative value, to thousands of pounds or inch-pounds in a fraction of a second, at a thousand or more times an hour. This reversal can occur 10 to 20 million times per year. The design and selection of equipment which will stand such a range of stress is of utmost importance to the oil industry from the standpoint of economics. Equipment which will not stand up under such treatment cannot be used without constant high maintenance and operating costs. There are other causes for failure of equipment than excessive stress, but to obtain basically correct selection and design for equipment which will give optimum results, the test engineer applies the knowledge obtained when making a complete well analysis.

The well-weighing program showed that for a company to obtain the desired results of maximum production at the least cost for the longest period of time, a pumping well installation must be designed and operated under conditions which will give maximum efficiency for all factors involved, during all periods in the life of a well.

To obtain these optimum producing conditions, a constant vigil must be maintained to detect and eliminate detrimental conditions which would cause a rise in operating costs or a reduction in production. This vigil is kept by the test engineer, who is as much of a specialist or diagnostician in his line, as a medical doctor who specializes in diagnosing human ills. The test engineer applies his technical knowledge so that each well is produced in a manner which will give the greatest over-all return on the investment.

ACKNOWLEDGMENT

The writer deeply appreciates the opportunity afforded him by The Atlantic Refining Company in granting him permission to prepare and publish this paper.

TABLE 1

YEAR	No. of Wells	NUMBER OF JOBS				RATE OF INCIDENCE			
		Rod	Pump	Tubing	Total R-P-T	Rod	Pump	Tubing	Total R-P-T
1943	137	170	160	83	413	1.24	1.16	0.605	3.014
1944	137	123	165	113	401	0.897	1.20	0.824	2.926
1945	130	223	220	213	656	1.72	1.69	1.64	5.046
1946	120	223	192	86	501	1.85	1.60	0.72	4.175
1947	120	116	167	75	358	0.96	1.39	0.63	2.983
1948	124	125	134	36	295	0.99	1.08	0.29	2.378
1949	138	153	162	50	365	1.108	1.174	0.362	2.645
1950	149	128	152	47	327	0.859	1.02	0.315	2.194
1951 (Thru Sept.)	157	67	88	10	165	0.426	0.561	0.0637	1.051

TABLE 2

YEAR	Average Cost per Job		
	Rod	Pump	Tubing
1943 thru 1946	$ 73.00	$ 89.00	$178.00
1947	61.00	127.00	268.00
1948	76.00	120.00	240.00
1949	74.00	125.00	188.00
1950	114.35	151.45	260.80
1951 (Thru Sept.)	118.36	122.89	146.31

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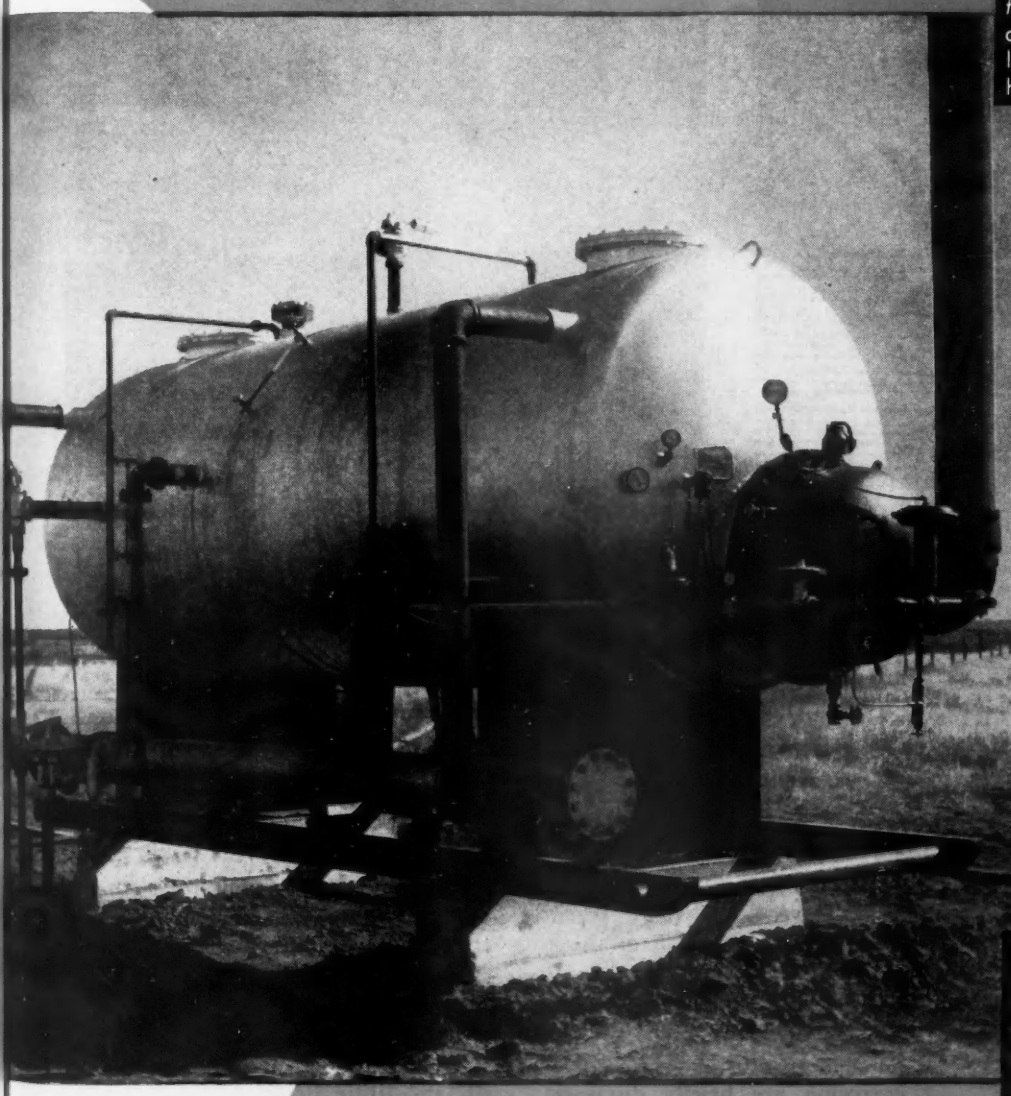
IN THE *NEW* BS&B *horizontal* treater controls are conveniently grouped and located for piping and housing.

FOR MAINTENANCE, all sections are easily accessible. Each compartment can be drained separately without draining balance of treater.



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NOTE: The *new* Black, Sivalls & Bryson *Horizontal* Treating Unit has already been field-tested and proven. These *horizontal* treaters are AVAILABLE FOR DELIVERY. Sizes . . . 6'x14' . . . 6'x21' . . . 8'x21' . . . 10'x21'. Auxiliary units are available for attachment to the treater at the factory or in the field with a minimum of time and cost.

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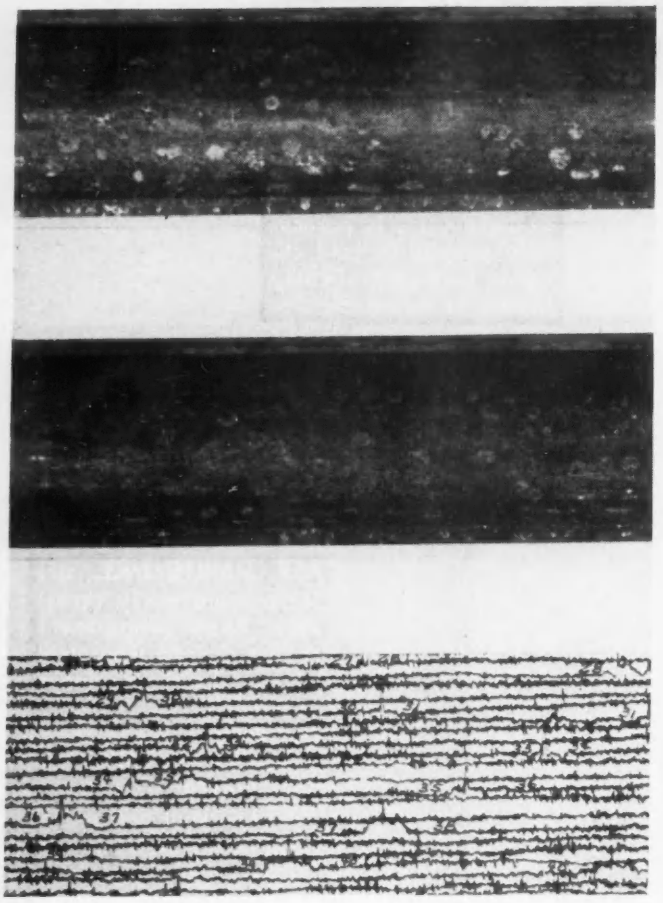

FIGURE 1. Typical attack by high-pressure, sweet oil corrosion. General pitting is similar to condensate corrosion.

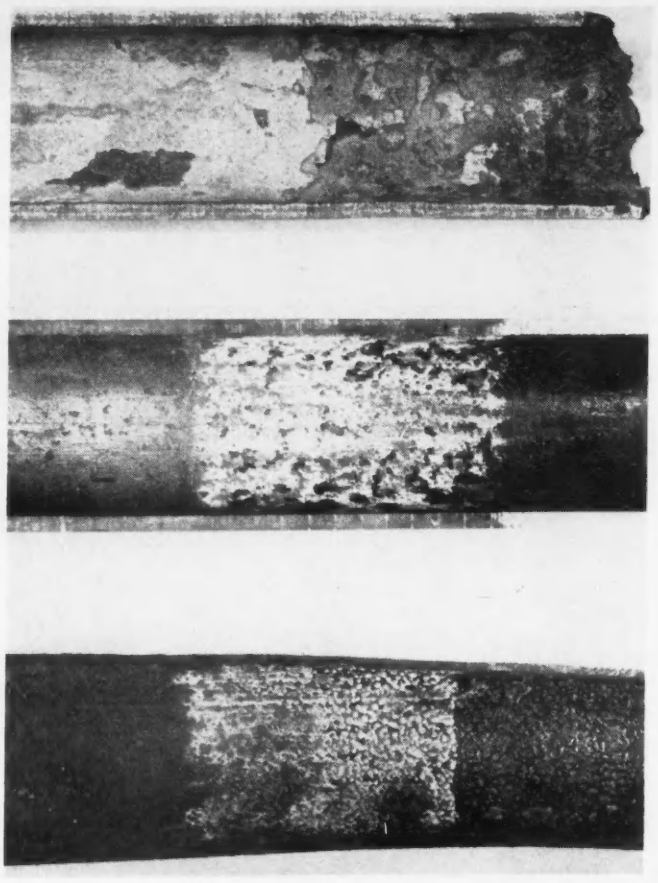

FIGURE 2. Ringworm corrosion and typical scale formation, commonly found in high-pressure sweet oil corrosion.

SWEET OIL WELL CORROSION

By H. L. BILHARTZ

The Atlantic Refining Company, Dallas

THE economic importance of sweet oil well corrosion was recognized only in recent years. An attack on tubing in high pressure sweet oil wells in southeastern Louisiana was observed for the first time in 1945. The seriousness was not fully comprehended until 1948, when a high-pressure well blew out as a direct result of corrosion. The monetary loss of this single failure was $150,000 plus loss of the well. Subsequently $½ million was spent on corrosion in this field by one company in one year. Careful investigation by other companies revealed that serious corrosion was occurring in most wells in the general geographic area.

This particular problem constitutes one of the two major concerns of the corrosion engineer interested in "sweet" oil well corrosion. The other deals with lower pressure wells and was recognized even more recently. It is predicted that corrosion costs chargeable to this single problem will be approximately $3 million this year. For the sake of expediency the two projects have been named by industry as "High Pressure Sweet Oil Well Corrosion" and "Low Pressure Sweet Oil Well Corrosion." It is quite probable, however, that with the advent of a clearer understanding of the mechanism of attack, the two problems will be closely related. The principal differences at this time are twofold:

1. Severe corrosion has been noted under high-pressure conditions where little or no water is produced. By contrast, a critical water-oil ratio, usually in excess of 50 percent water, must be exceeded before perceptible attack occurs in the "low"-pressure category.
2. Corrosion becomes active im-

PROBLEMS OF high-pressure and low-pressure sweet oil well corrosion are briefly discussed from a standpoint of investigative approach, criteria, causative agents and remedial measures. This is a report of the preliminary findings of representatives of about 30 companies, participating in a subcommittee of the Oil and Gas Production Committee of the National Association of Corrosion Engineers. This paper was presented before the Southwest API District meeting held in Shreveport March 5-7, 1952.

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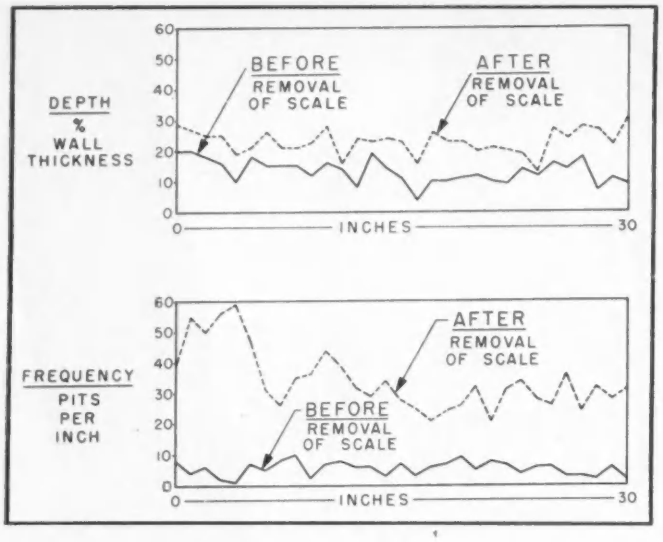

FIGURE 3. Effect of scale removal on visual pit frequency and depth.

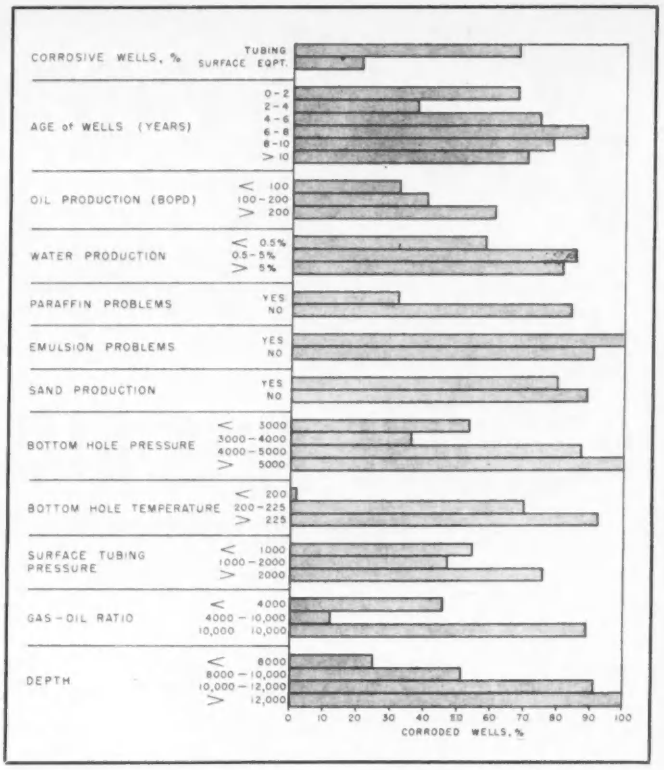

FIGURE 4 (right). Results of statistical study of corrosion in high-pressure sweet oil wells, based on reports from 359 wells.

mediately after production is commenced in the high-pressure environment, whereas many years (10-15) of corrosion-free operation has been observed in the other category before serious metal loss occurs.

Method of Approach

It became apparent shortly after recognition of the problems that cooperative effort between producing companies could expedite an economical solution. The Technical Practices Committee framework of the National Association of Corrosion Engineers provided an excellent clearing house or forum whereby about 30 participating companies could pool their technical effort. A subcommittee of the Oil and Gas Production Committee was founded to consider all aspects of "sweet" oil well corrosion. Through the combined efforts of technical men from these companies, progress was far more rapid than could have been possible with engineers working individually.

In order to develop definitive data pertaining to the high-pressure problem, a questionnaire was submitted to companies participating in the NACE committee. This questionnaire considered the correlation of various producing variables with the rate of corrosion, scope of the problem, causative agents, criteria, and remedial measures. Data obtained from this survey revealed many characteristics unique in this problem.

General pitting (Figure 1) similar to that experienced in condensate wells was reported. An average of 75 pits per linear foot were observed in some sections of tubing removed from corrosive wells. These pits were characteristic of carbon dioxide attack. Subsequent analysis proved acid gas to be the primary causative agent. Organic acids were detected in unusually large concentrations. It was concluded that this constituted a secondary causative agent.

Intensity of corrosion was noted to vary a great deal within a field. In rare instances complete penetrations developed in one year. On the other hand eight or ten years of trouble-free service were experienced on offset wells. In general the average tubing life was three or four years. Ringworm corrosion shown in Figure 2 was isolated but proved troublesome and costly during workover operations.

Possibly the most striking observation disclosed was that severe corrosion occurred in wells producing pipe line oil. Traces of water, officially reported as 0.1 percent, were sufficient to radically reduce tubing life. To the author's knowledge this phenomenon had never before been recorded. Under these circumstances it was and is difficult to explain the exact mechanism of attack. Various theories, which are beyond the scope of this paper, leave much to be desired in the way of a rigorous explanation.

Scale conditions noted also defied explanation. Two types of scale (Figure 2) were reported, one a thick, heavy, white, cement-like material which proved to be barium sulfate, and the other a red oxide-appearing coating over a thin barium sulfate deposit. The red over-coating was honey-combed in appearance and very hard.

The scale deposition became of more than academic interest when it was realized that such a hard material seriously affected the results of tubing caliper surveys. Such surveys normally dictate workover operations. The effect is best illustrated in Figure 3. A substantial increase in pit depth was measured subsequent to scale removal. In addition the visually determined frequency of pitting increased by a factor of 10 after tubing had been cleaned of scale.

Criteria of corrosion for a given environment are always difficult to establish. It was at first assumed, because of the similarity of attack, that the criteria so laboriously arrived at during the concentrated investigation of condensate well corrosion would be applicable. Factors considered in these criteria were as follows:

- Surface coupon tests.
- Iron content determination.
- Carbon dioxide content.
- Organic acid content.
- Tubing caliper survey.

Surface coupon tests in this problem proved of no value because of severe paraffin deposition. Iron con-

centration was of little significance since it was practically impossible to sample water produced from "pipe line" oil. In wells where significant water was produced, correlation of corrosion rate versus iron content was poor. There was a correlation with carbon dioxide and organic acids. As discussed previously, it was concluded that these two compounds constituted the causative corrosion agents.

The value of the tubing caliper, though still important, was obscured by the unique scaling conditions, rendering interpretation of data difficult.

Figure 4 illustrates the results of the statistical section of the questionnaire. It may be seen that 42 percent of the wells in the subject category displayed tubing corrosion and 20 percent surface equipment attack.

There was no correlation with age of wells signifying that corrosion became evident very soon after production was started. A direct correlation was noted with oil production rate. As expected from preliminary observations, no correlation was derived from percent or total water production.

Paraffin, emulsion, and sand problems, were equally independent of corrosion rate. A reasonable correlation with bottom-hole pressure was observed, with increased pressure resulting in increased corrosion. Bottom-hole temperature displayed a significant pattern. Corrosion incidence was directly related to temperature. Surface tubing pressure and gas-oil ratio displayed little related evidence. A direct correlation existed between corrosion frequency and well depth. The latter is especially significant for several reasons. Workover costs on these wells are particularly high, and the trend is toward deeper drilling, especially in southeastern Louisiana where this problem has been most prevalent. These factors would indicate that economic stakes of this problem will increase in the years to come.

Remedial Measures

The development of economical remedial measures proved difficult. Most commonly employed techniques were inadequate or could not be economically applied. Thermosetting plastic coated tubing was installed in the early days. Figure 5 illustrates its effectiveness. It reduced general attack, but isolated pits began to form within 19 months. The advantage of this technique was thus subjected to some doubt because one complete penetration in a 10,000-foot well necessitated a workover. In all fairness to this approach it must be emphasized that the product used during the early days of the test has been improved. Subsequent tests may tend to minimize the noted disadvantage. Thermosetting plastic-coated tubing costs approximately twice that of unprotected pipe. To date 310,000 feet have been installed in wells of the subject category.

Nine percent nickel tubing was installed originally because of its successful use in the condensate well environment. Approximately 100,000 feet have been installed in one area of southeastern Louisiana. Only minor evidence of attack has been noted. Figure 5 illustrates the perfect condition of 9 percent nickel after one year's service. Nine percent nickel tubing costs 3.8 times that of J-55 tubing. Unfortunately, this material is no longer available to the oil industry, so it has become necessary to develop other methods of alleviation.

Both galvanized and nickel-plated pipe have been tested under actual in-hole conditions. Galvanizing failed immediately. Results of the nickel-plated tests are not yet available, though the data will be only of academic interest since this material, too, is no longer available for use in this manner.

Inhibitors were at first thought impractical because of inherent difficulties encountered in releasing the inhibitor in the bottom of the well. Due to the high pressures involved, packers and mud-filled annuli were almost universally accepted as necessary. Therefore, the only means of introducing an inhibitor was through the tubing. Since the tubing was always

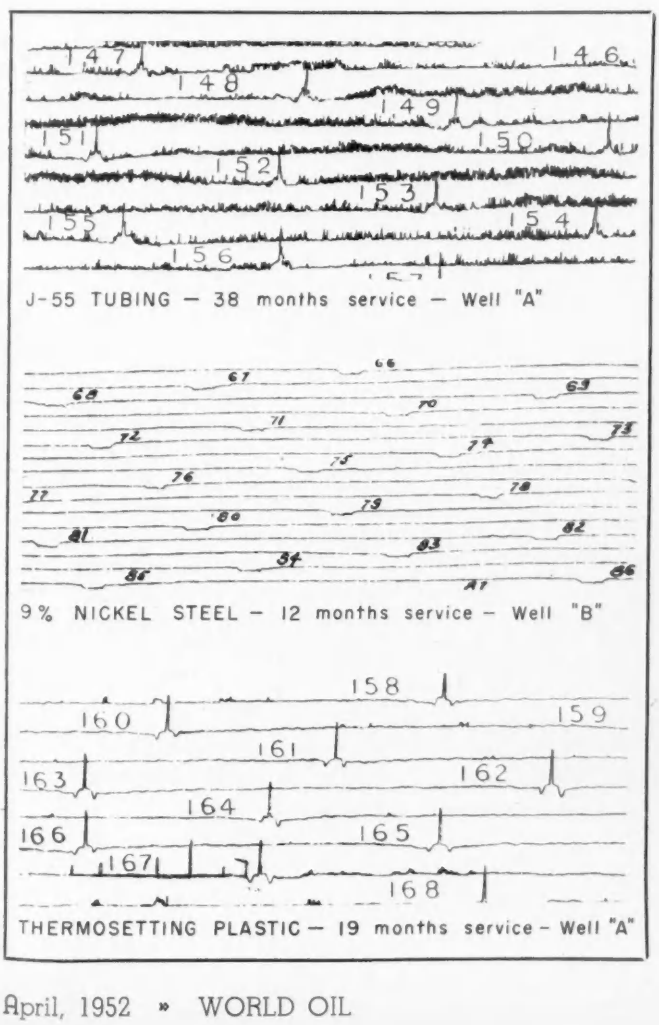
J-55 TUBING — 38 months service — Well "A"
9% NICKEL STEEL — 12 months service — Well "B"
THERMOSETTING PLASTIC — 19 months service — Well "A"

FIGURE 5. Survey of pitting in three kinds of tubing.

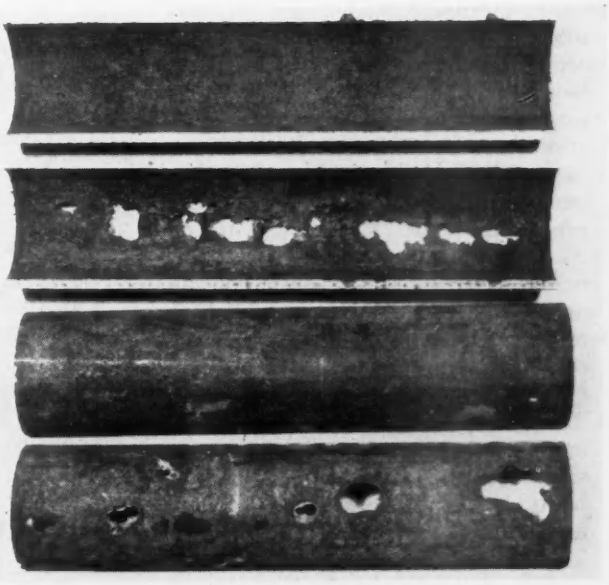

FIGURE 6. Typical attack of low-pressure sweet oil corrosion.

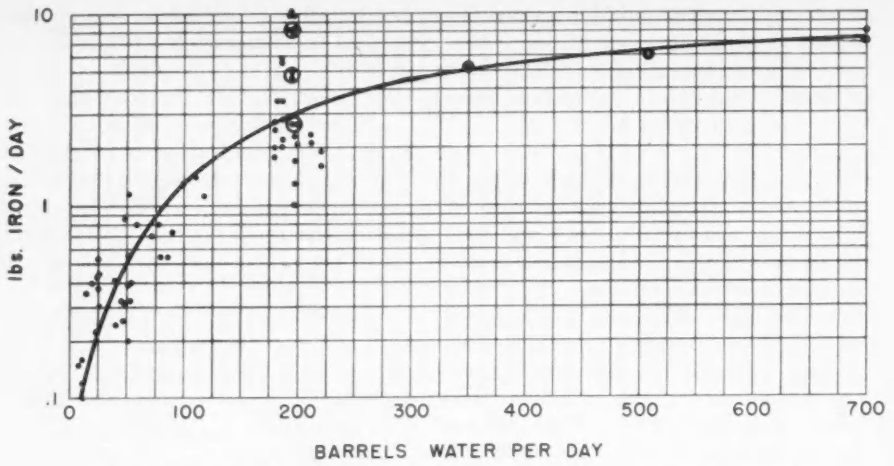

FIGURE 7. Pattern for corrosion prediction: Iron loss vs. water produced.

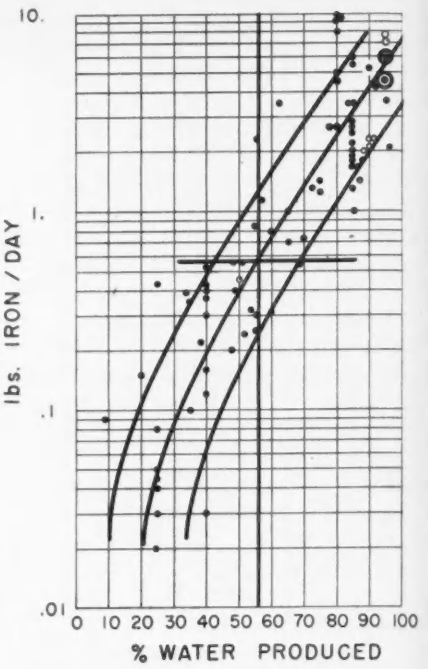

FIGURE 8. Pattern for corrosion prediction: Iron loss vs. water percent.

full of produced fluid, it was necessary that weighted stick inhibitors be employed. The cost of adequate treatment in many instances equals that of replacing tubing every three or four years. With the shortage of steel rendering economic considerations to a status of secondary importance, however, several companies are utilizing this method of mitigation. It is hoped that developments in this field of endeavor will improve the economic picture. Meanwhile every effort is being made to extend the life of tubing now in place through the duration of the national emergency.

Low Pressure Project

Second of the two problems, "Low Pressure Sweet Oil Well Corrosion," was first observed only two years ago. Figure 6 illustrates the type of attack. Literally hundreds of holes developed in as little as nine months. Due to the rather strange conditions surrounding the initial observations, little thought was given to its potential seriousness. Instead, it was thought that some freak attack had occurred which would be isolated. As more and more reports of failures were made, the seriousness of the situation became alarming. The unique factor which characterized this phenomenon was essentially that wells produced 10 to 15 years with no symptom of corrosion. After this period of trouble-free operation an unexplained change occurred which reduced the tubing life to two years or less in many instances. A preliminary survey conducted by the NACE TP-1 committee revealed that several companies were experiencing the same trouble in numerous sweet oil fields. It was acknowledged immediately that the magnitude of the problem warranted industry-wide consideration. Accordingly, the NACE committee TP-1C on "Sweet Oil Well Corrosion" undertook it as a major project.

To provide necessary statistical data as well as individual well data, a questionnaire was submitted to all companies participating in committee activities. The questionnaire was composed of two parts. One dealt with the accumulation of factual data and personal comments related to various fields from a field standpoint. The second dealt with basic production data, corrosion history, and analytical information on individual wells. It is expected that all fields thought to fall into this category will be covered in the survey. To date questionnaires have been requested by various companies which account for approximately 150 fields.

For each field numerous individual well forms will be completed. It is expected that within a field one well where no corrosion has yet been experienced will be reported for each corrosive well. Approximately 1000 individual well forms have been distributed.

Purpose of this questionnaire was to define the magnitude of the problem, to exchange ideas pertaining to successful or unsuccessful remedial measures, and to develop a criteria of corrosion.

Though sufficient time has not elapsed to allow complete return of these forms, it has been noted from preliminary data that:

- Corrosion does not occur below some critical water-oil ratio.
- The extent of corrosion after the critical value has been exceeded varies according to fluid velocity and total corrodent.
- Gas-lift accelerates corrosive attack.
- Organic acids are probably the most active corrosive agents. Carbon dioxide may also be significant.
- Inhibitor injection is in general the most economical remedial measure.

Remedial Measures

As concerns remedial measures employed, the customary injection of organic inhibitors into an open annulus has afforded protection in many instances. Conditions existing in other locations render this technique valueless. For example, the inhibitor does not penetrate the high fluid level in many wells with the result that protection is not attained in lower zones.

Water soluble inhibitors with a specific gravity greater than brines are being tested. Commonly available stick inhibitors have been lubricated down the tubing. This practice met with difficulties, particularly in wells where the bottom hole temperature was too low to melt the binding material. Sticks which function independent of temperature have been developed and are being field tested. Complete test results of various techniques will be forthcoming soon. It is anticipated that within a year successful remedial measures will be established for most conditions.

Relative to the significance of water-oil ratios, it is known that critical values will vary from field to field. Such a figure has been empirically established for several environments. In the U. S. all ratios to date have been greater than 50 percent water. Very recently, a value of 40 percent was tentatively established

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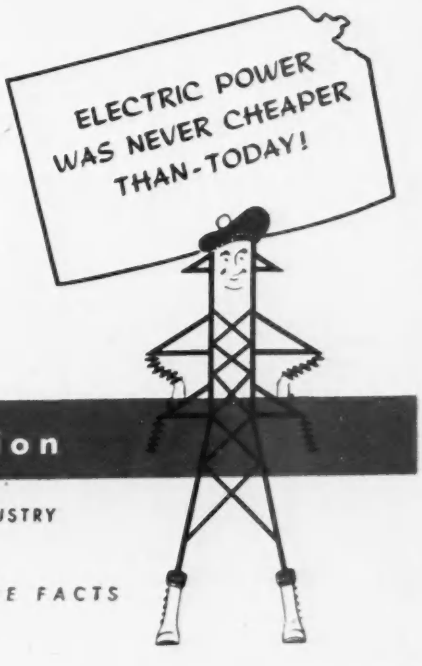

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for one field in Venezuela. Figure 7 shows the pounds of iron per day, which is a measure of corrosion activity, with barrels of water produced. It has been established empirically for wells approximately 5000 feet deep that iron loss in excess of 0.5 pounds per day is indicative of severe attack. These data show that for this particular field the critical quantity is reached at 50 barrels of water per day. Figure 8 relates pounds of iron with percent water. For this field, the critical value is 55 percent.

Instances have been reported where cited critical values vary within a given well dependent upon producing equipment. In one field, for example, water percentages of 98 percent can be tolerated on flowing wells with little effect, whereas corrosion activity is severe when 70 percent water is produced by gas-lift.

These data on the other hand are contradicted by reports on other fields which show that severe attack takes place when little or no gas is used for lift purposes. The drop-size ratio is felt to provide a key to the explanation of discussed variations. If this relation can be established by compilation of empirical data on a sufficiently large number of wells, an important step toward accurately predicting corrosion will have been achieved. Production characteristics of a given well are usually available. Thus, if the relation of these values to an easily measured physical property, such as drop-size ratio, is known, it will be a simple matter to predict not only whether a given field is susceptible of attack, but if an approximate date of initial corrosion activity can be anticipated. The ramifications of a pattern such as this are readily apparent. Prediction and control of corrosion can become a matter of applying known principles rather than trial and error methods. Master control sheets Figure 9 can be maintained on wells in all fields where causative agents exist. Then, as the anticipated change-over from the dormant, passive environment to the actively corrosive stage becomes imminent, a careful check of water analysis and coupon exposure tests can dictate remedial action. In this manner premature treatment of thousands of wells can be avoided without danger of costly failure.

Establishment of the aforementioned data is a tremendous task. The accumulation of information from several hundred corrosive and non-corrosive wells will be required. Such information will include:

- Annual water production
- Annual oil production
- Injected gas-oil ratio
- Produced gas-oil ratio
- Corrosion history
- Well completion practices
- Water analysis
- Gas analysis
- Drop-size ratio

Under the best conditions the collection of these data is difficult and it is almost impossible for any one company to accomplish it. With the 30 companies pooling their efforts through the Oil and Gas Production Committee of the NACE, it can be done with a minimum of effort and expense to any one organization.

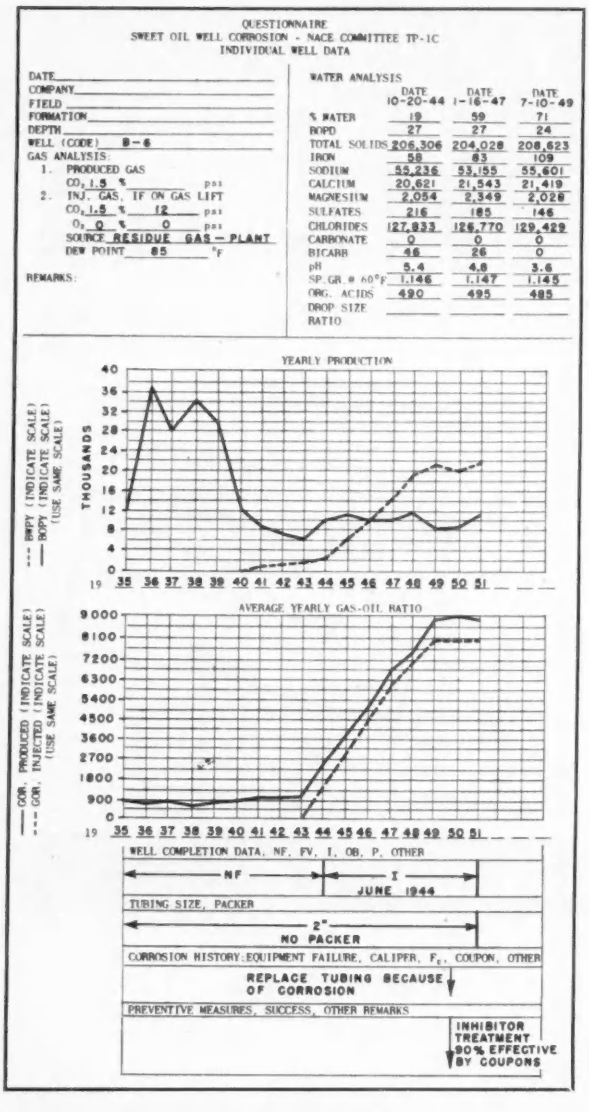


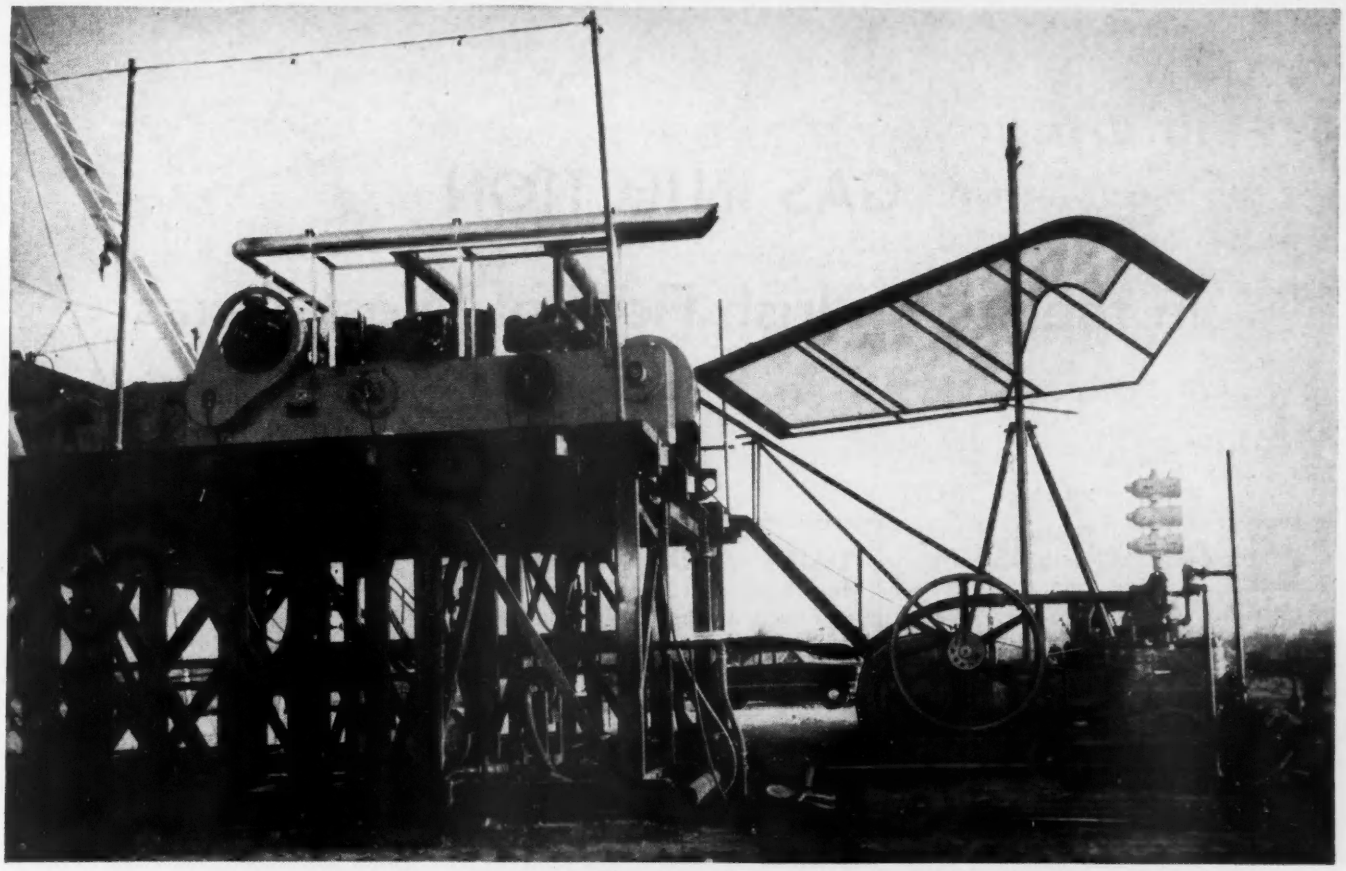
FIGURE 9. Questionnaire on sweet oil well corrosion sent to about 30 participating companies by the NACE Committee TP-1C.

About the Author

HARRELL L. BILHARTZ, chemical engineer in the Production department, The Atlantic Refining Company, Dallas, received undergraduate training at Southwestern University and graduate training at Harvard and Massachusetts Institute of Technology. He served three years in the Navy during World War II. He is active in committee activities of the NGAA and NACE, and is a member of AIME. He has headed the NACE Committee TP-1C on sweet oil well corrosion since its inception and will succeed to national chairman of the Oil and Gas Production Committee of NACE this year.

Conclusion

The sweet oil well corrosion projects discussed in this paper represent only two of the many costly corrosion problems in the petroleum industry. It is important that immediate consideration be given to the conservation of steel materials in these and other environments. In normal times corrosion prevention was justified solely upon economic considerations. The cost of study plus remedial costs had to be such that significant profit over normal operations could be shown. However, in times of international tension such as we are undergoing today, where heavy defense programs greatly curtail metal for civilian consumption, we are being forced more and more to conserve the metals we have. Reduction of corrosion is the prime factor in this conservation. Effective control of corrosion can be achieved only by engineers trained in its technology. These engineers can do their best only if they solve their general problems cooperatively.



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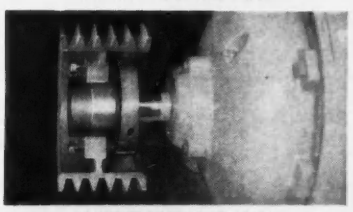

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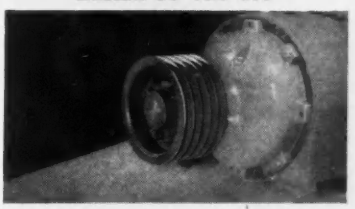

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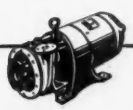

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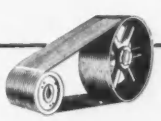

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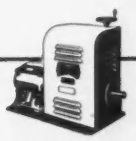

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GAS INJECTION

In the Anton-Irish Field of West Texas

GAS injection operations were commenced Jan. 16, 1952, to climax prolonged efforts to provide a suitable conservation program for the Anton-Irish field, approximately 30 miles northwest of Lubbock, Texas. This was the final phase of a unitization and secondary recovery project designed to increase the ultimate recovery of crude oil from the field.

Final approval by the Texas Railroad Commission was granted June 22, 1951. The Anton-Irish unit became effective the following July 1, with Stanolind Oil and Gas Company as operator. Negotiations for the unit were begun more than three years ago and completed in May, 1951.

The allowable per well in the field was 42 barrels a day before the start of the injection program. Effective Feb. 1, 1952, however, the Railroad Commission approved an allowable of 100 barrels per well per day, in recognition of the fact that the conservation project had been completed and placed in operation.

DAILY WELL allowables have increased from 42 to 100 barrels per well as the result of a gas injection program in The Anton-Irish field. Here is another example of benefits reaped from a conservation program where outside gas had to be purchased to fulfill requirements for an adequate secondary recovery operation. The field produces from the Clearfork dolomite at an average depth of 5900 feet.

The oil contains only a small amount of gas in solution (solution gas-oil ratio is 148 cubic feet per barrel). Consequently, to carry out the initial phases of the injection program, it is necessary to purchase gas from outside sources. The gas is obtained from the El Paso Natural Gas Company. A line to carry the gas to the field, a field compressor station, and gas distribution system were completed by the operators prior to the start of actual injection operations.

Figure 1 shows the general location of the field with respect to Lubbock and some of the major producing fields in the area. Figure 2 is a contour map of the field which also shows the boundaries of the unit, the location of the compressor station and the approximate route of the gas line from El Paso's main line.

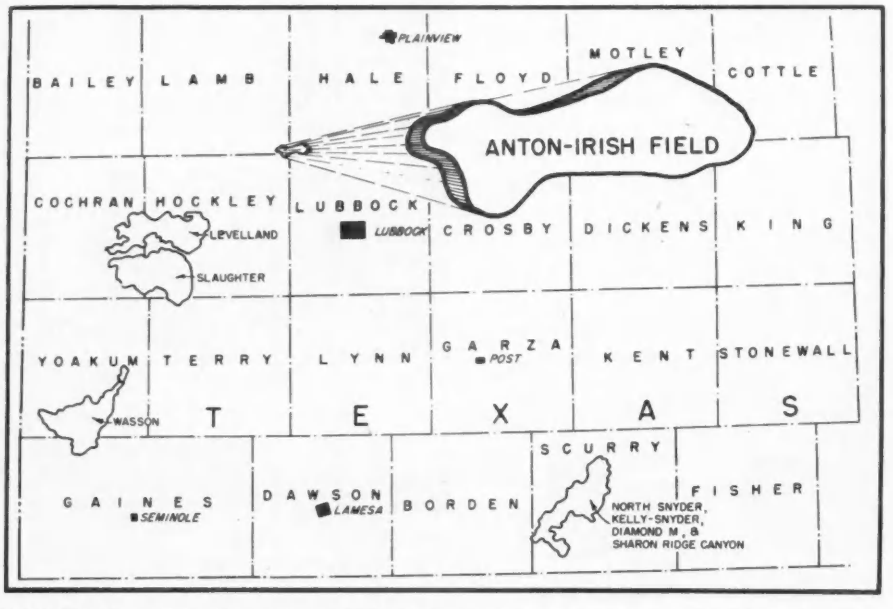

FIGURE 1. General location of Anton-Irish field, some 30 miles northwest of Lubbock. It lies at the hub of Lubbock, Hockley, Lamb and Hale counties.

Discovered in 1944

Lying approximately at the intersection of Hockley, Lamb, Hale and Lubbock counties, the Anton-Irish field originally was thought to be two separate pools. The west dome, or Anton portion of the field, was discovered in December, 1944, with the completion of Humble Oil and Refining Company's J. A. Jackson 1. This well was subsequently acquired by Anton Oil Corporation. The east dome, or Irish part of the Anton-Irish pool was brought in by Stanolind Oil & Gas Company, with its Lee Irish "A" 1, in April, 1946. Subsequent development showed that the two fields were actually part of the same reservoir, and the Railroad Commission designated them as one —Anton-Irish.

The structure is an elongated anticline with local closure on the eastern and western portions. Production is from the Clearfork dolomite at an average depth of 5900 feet. The general spacing pattern is one well to each 40 acres.

After discovery of the east dome of the field in 1944, development was rapid through 1949. By mid-1948, bottom-hole sample analyses, produced gas-oil ratios, and reservoir pressure behavior had shown that the

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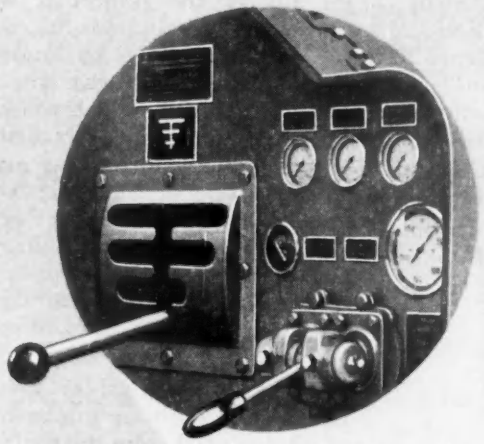

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oil in the reservoir had only a small amount of gas in solution. Since fluid expansion and dissolved gas were the principal sources of energy, it became apparent that recovery efficiency would be relatively low unless some type of secondary recovery project were inaugurated.

Preliminary engineering studies showed that the field was well suited to a dispersed type gas injection program. Such a program was agreed upon, even though it was apparent that it would entail buying gas for injection from a source outside the field. Produced solution gas is barely enough to meet fuel and lease requirements and is not sufficient for injection at the desired rate.

Engineering studies showed that the field should be unitized in order to conduct most efficiently the dispersed type gas injection program. In the latter part of 1948, a preliminary engineering prospectus dealing with unitization and gas injection was distributed to the working interest owners in the field and a meeting was called to discuss the proposed program. The operators were enthusiastic about the possibilities of the program. There followed a series of operators' meetings and engineering and geological committee studies, which ended in the operators' agreeing on unitization and gas injection late in 1950.

During the next six months, the program was presented to royalty owners to obtain their approval of unitization to permit gas injection on a field-wide basis. In general, they were very receptive to the program, since it would be conducted at no cost to them, and would result in increased benefits to them—as well as to the operators—as the result of conservation and increased oil recovery.

At the time of the public hearing on May 31, 1951, held to present the unitization and injection program to the Texas Railroad Commission for approval, 87 percent of the 232 royalty owners in the field, owning 75 percent of the total royalty interest, had signed the agreement. The commission approved the unitization and gas injection program on June 22, 1951, permitting the Anton-Irish Clearfork Unit to become effective July 1, 1951. The unit includes 6110 acres and 136 of the 144 wells completed at the time of unitization. Figure 2 shows development, the unit boundaries and the probable initial gas input wells.

Pressure Increased

Makeup gas for the injection program, purchased from the El Paso Natural Gas Company, is sweet, dry gas available at a pressure of 650 to 700 pounds per square inch gauge. For injection purposes, the pressure is increased to 1500 psig at a compressor plant in the field. The plant has an initial capacity of 2 million cubic feet per day, while the distribution system for the injection gas is sized for 20 million cubic feet daily. Initially, there will be 12 input wells in the field.

Injecting gas into the reservoir will slow down the natural decline of the reservoir pressure, which was 2021 pounds per square inch absolute initially. This will result in maintaining the producing capacity of the wells at a higher barrels-per-day rate than would be possible if gas were not injected. The injected gas also will serve in much the same way as gas evolved from solution, in that it will supply energy for moving additional oil to the well bores.

While it will be necessary initially to purchase an appreciable amount of makeup gas for injection, later in the life of the project it will be possible to obtain most of the gas needed for injection by collecting produced casinghead gas. The future injection program, which will be controlled by an operators' committee, may eventually include as many as 30 input wells and injection volumes up to 20 million cubic feet per day. However, the program will be flexible and necessary changes will be based upon future reservoir performance, in order that the most efficient recovery will result.

The characteristics of the crude from Anton-Irish are similar to those of oil produced from the Cedar Lake field in Gaines County, Texas, where gas injection operations have been successfully conducted for several years. Accordingly, operators are confident of comparable results at Anton-Irish. A substantial amount of additional oil is expected to be recovered at Anton-Irish as the result of the program.

Stanolind Oil and Gas Company will operate the unit for the working interest owners, who include, besides Stanolind: Anton Oil Corporation, A and H Oil Company, Gulf Oil Corporation, Hunt Oil Company, Carolyn Hunt, Trust, Estate; Magnolia Petroleum Company and The Pure Oil Company.

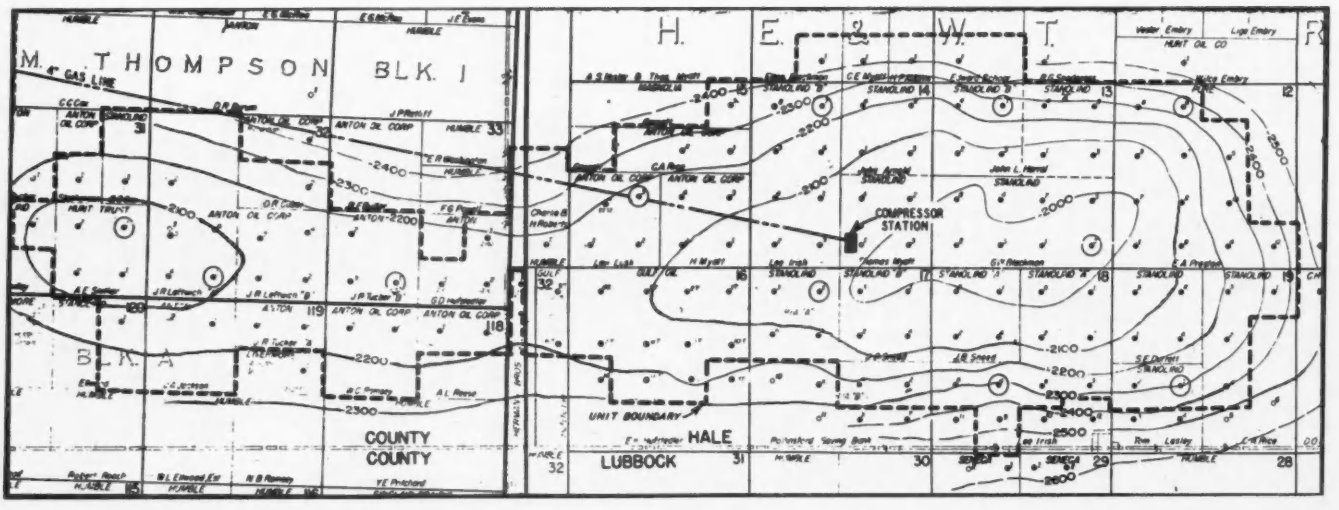

FIGURE 2. Outline of Anton-Irish field, with contours made on radioactive markers with 100-foot interval. Dotted lines show unit boundaries and large circle indicate injection wells. Unit may have up to 30 injection wells during the latter stages of operation.

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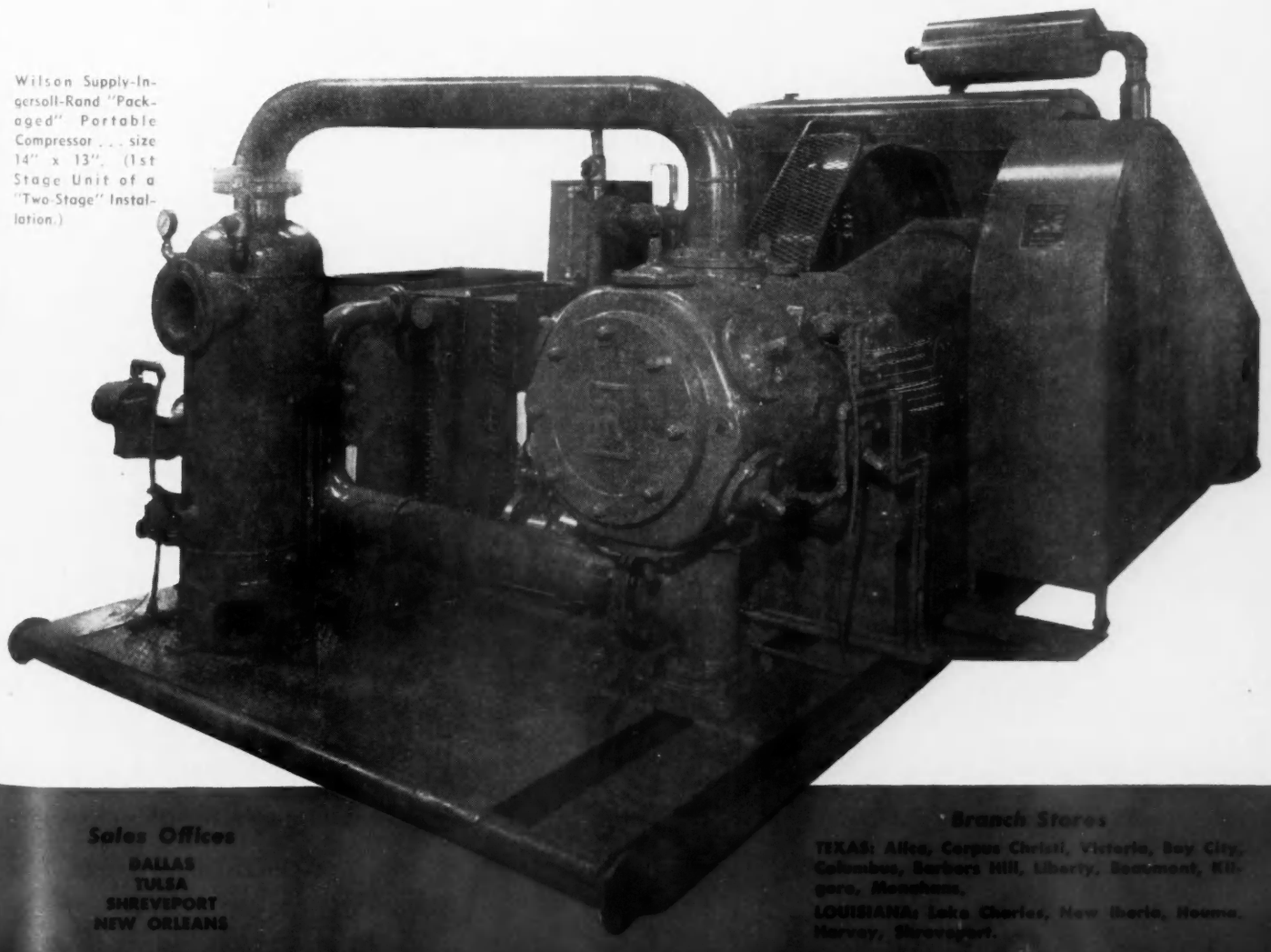

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SLUDGE EFFECTS ON OIL BEHAVIOR

By F. R. COZZENS

Equity Oil & Gas Company, Stockport, Ohio

OIL WELL sludges and their effect on oil production are discussed. The author defines sludges, what they consist of and how they are formed. Sludges formed within the drainage radius of the reservoir surrounding the well bore, and some remedial measures to minimize their effect are described in detail. The second phase of sludge action, which occurs in the well bore, is also presented. The author discusses means of detecting and remedying sludge conditions, and compounds to be used in cleaning wells affected by sludge. Identification and analysis of sludges from Pennsylvania, Illinois and Texas are included.

AMONG the many factors which restrict oil movement within a subsurface reservoir, sludges are the most variable in action, and generally the least suspected in effect.

Sludge is an elastic term which can be defined as emulsified sediment, or a gelatinous compound resulting from the infusion of oil-water emulsions with clay, calcium carbonate, silica, mineral salts and deposits, and other base constituents of a petroliferous formation.

There are many causes for such infusions, some of which are not clearly understood. Considerable evidence supports the theory that electromagnetic impulses within the reservoir are basic factors. Obviously, organic growths play an important role since bacterial colloids are common in sludge specimens. It is probable also that oxygen and chemically-formed gases serve as emulsifying agents under certain conditions, inasmuch as sludge segments generally carry a preponderance of air and gas bubbles which are enveloped in a film of oil. Strata constituents serve to stabilize the emulsified structure, and once unification has been established, the resultant substance becomes a member of the sludge category.

Case histories reveal the existence of at least 20 distinct sludge compounds which can reduce oil volume and flow rate, the more common types being locally identified by pumpers and lease crews as "floating-sand," "gumbo grease," "gypsum soap," "bore wax," "brine slime," etc. Some of the compounds occur within the drainage system of a formation and are produced with the oil, being normally gravitated towards the well bore. Other types are generated within the bore, affecting principally the bore base, but are often forced unintentionally into the formation by oil producing techniques.

While sludges differ considerably in color, composition, and behavior, practically all types have one characteristic in common: Their binding structure disintegrates under pressure, and the released segments, which retain the basic properties of the parent body, are capable of remaining suspended in either oil or water for considerable time. While suspended in fluid, they can migrate or congeal, or separate and regroup as justified by reservoir environment. Due to such diversity in makeup and action, sludges become plugging agents which can penetrate and damage an unpredictable area of oil bearing formation.

SLUDGE ANALYSIS*

Identification	Specimen No. 1	Specimen No. 2	Specimen No. 3
State	Penna.	Illinois	Texas
Area or District	Bradford	Marion Co.	Hopkins Co.
Reservoir	Brad. 3rd	Bethel S.	Pickton, F.
Type of Sludge	"Floating S"	"Gumbo G."	"Bore Wax"
Condition	Spongy	Semi-solid	Viscous
Color	Gray	Brownish	D. Brown
Matrix	Organic Col.	Organic Col.	Organic Col.
Major Constituent	Wax	Gypsum	Wax
Free Oil†	2%	Trace	1%
Waxes‡	10%	3%	3%
Analysis:			
Calcium Car. ($CaCO_3$)	7.0	22.50	28.66
Barium (Ba)	10.0	8.00	Trace
Iron Sulfur (FeS)	6.1	14.00	9.50
Magnesium ($MgCO_3$)	Trace	1.50	1.50
Aluminum Oxide (Al_2O_3)	3.5	1.88	3.95
Silica (SiO_2)	66.2	12.10	10.88
Organic Matter	4.5	14.10	36.70
Unidentified	0.0	4.12	1.50

* Compiled from Analysis Files of the late Wm. M. Carr, former president, Equity Oil and Gas Company.

† As removed with hot acetone.

‡ As determined at temperatures of 160° F.

Formation Sludges

There is no authentic evidence to prove that sludges ever occur in virgin formation. However, when an area of that formation is punctured by the drill, virgin energy, in the form of gases and fluids, is released and directed towards the opened bore. For this purpose, new flow courses and appendages are opened, many of which are not in accordance with directional flow trends naturally established through the reservoir.

As is invariably the case when fluid movement through virgin rock is diverted, the making and maintenance of new flow-channels creates sediment, mainly in the form of sand-particles, soluble clays, silt, and other constituents which can be actuated by fluids and gases. This residue readily unites with the base sediment normally carried in solution by most crude oils, and is moved along with the fluid towards the well bore. Almost invariably, enough water is pro-

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duced with the oil to form an emulsion. Since the foundation is already prepared for its infusion with sediment, a typical sludge compound can be formulated anywhere along the drainage route by: (a) friction, afforded by the channel walls; (b) temperature fluctuations between bore face and formation (c) water pressure against the oil, resulting in so-called Jamin actions; (d) gas expansion, causing a too rapid release of lighter fractions of oil into the bore. Doubtless, many other unidentified causes enter the picture.

Ironically enough, many sludge forming factors must be amplified in conditioning a new well for production, because to gain a maximum quantity of oil it is generally necessary to fracture, perforate, acidize, or otherwise process a given area of formation around the bore. In a practical sense, the completed well becomes the receiving center for an area of processed formation, which can be termed its drainage radius. Logically, the farther back into the sand this radius extends, the greater will be the quantity of sediment produced, but as previously stated, the normal flow trend is towards the well bore, and as long as reservoir energy is sufficient to move the substance to its destination, few, if any, drainage difficulties occur. If, and when, however, deposits within the bore or along its face become sufficient in density or volume to build up resistance equal to, or greater than the energy being expended against it, the picture changes radically. Movement of residue within the drainage pattern is slowed down, and its congealment begins along the channels. Resultant back-pressures disintegrate the sludge accumulations, allowing segments to migrate in various directions through the drainage area, gradually occupying pore space until little or no room remains for the oil. Any well within a drainage radius thus affected becomes a stripper prematurely and its economic life is shortened because the ultimate productive potential is plugged back from the pumps.

Bore Sludges

The degree or volume of resistance eventually built up in a sludge-affected well is determined to a great extent by the techniques employed in completing the bore. In properly engineered wells, much of the residue conveyed from the drainage system settles harmlessly into the pocket or bore base, and the more soluble fractions are released with the oil through the pumps. However in many wells such normal release is curtailed or prevented entirely because of additional sludge compounds being formed within the bore. Bore sludges are formed basically from annulus sediment which results, generally, from reparable causes, such as: (a) casing being set too high above the oil producing horizon; (b) water encroachment through leaky casing or packers; (c) haphazard use of chemicals or heating devices within the bore. Other common causes are faulty cleanouts or workovers, miscalculations in shooting or perforating; interference from nearby abandonments; the use of raw water in flooding operations; and pressure parting or sand-splitting induced by extremely high pressures of either air or gas.

Any variety or deposition of sediment, regardless of its origin, is capable of becoming a basic part of a sludge structure, and since in most wells, oil-water emulsions are common and unavoidable, no method yet devised will prevent their infusion with sediment which is present in the bore. In numerous cases, such infusion and resultant disintegration is accomplished by mechanical energy, such as in pumping, flowing, swabbing, or by the misguided use of bore scrapers or cable tool bits.

Union of bore sludges with those which have already accumulated from the drainage system creates a treacherous status, inasmuch as the loosened segments can be backflowed into the formation, and encouraged to solidify behind the bore face. Once this condition has occurred, continuous agitation of the sludge mass converts many of the remaining segments into a gel, which gradually extends over the bore face and into the tubing and pumping equipment. The produced oil becomes more viscous, the production rate fluctuates, then recedes into a gradual but general decline until the well can no longer be operated at a profit. Ironically enough, the productive life of a sludge-locked bore generally terminates as a normal depletion despite the fact that cores taken from the formation, less than 50 feet from the "dead" well often reveal an oil content greater than 70 percent.

Sludge Detection and Removal

Since the bore base of an oil producing well serves normally as a catch basin for sediment, it is both timely and advisable to direct all sludge-corrective measures from that

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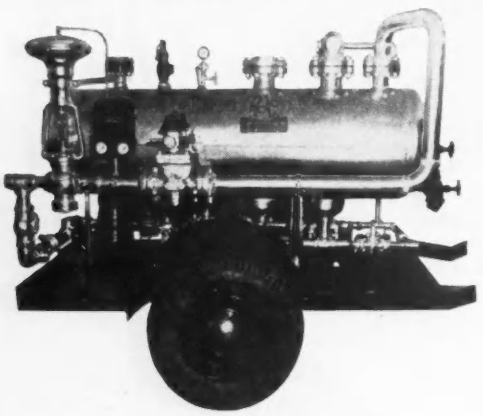

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point. Preceding any such measures there should be close inspection of the produced oil. Oil inspections are made, preferably, when a well is nearly pumped down, by placing a sludge trap, or a filter of finely meshed wire screen, over the mouth of the flow pipe, and allowing a barrel or two of the final production to pass through. Sludge segments, if present, will be caught in the filter, and when detected, generous samples should be submitted to a laboratory for analysis. By such analysis it is possible to identify some of the major constituents of a sludge compound so that counter-agents can be formulated into chemical treatments which prove very effective in eradicating the menace in its initial stages.

Chemicals usually employed for the purpose are not sludge solvents in a practical sense, but are designed primarily to break down the structure of a sludge by neutralizing one or more of its basic constituents. Once the structure has been broken apart, the remaining sludge components can be bailed or pumped from the well without further difficulty. In most sludge compounds, one of three basic constituents predominate:

- Calcium, or calcite-metallic crystals, which are neutralized by acid preparations, particularly hydrochloric acid in solutions of 15 to 20 percent.
- Waxes, or resinous compounds, which usually respond to paraffin solvents (commercial), drip gasoline, acetone, etc., or to electric heater units, capable of providing a bore temperature of 180 to 200° F.
- Organic growths, requiring the use of bactericides, such as chlorine, hypochlorite solutions, amines, complex phosphates, etc.

In a few types of sludge, salt crystals or clays are prominent, and these elements can generally be made soluble by water which has been chlorinated or made sterile as possible. A cohesion of mineral salts and bentonitic particles which forms the basic part of a few sludge structures is usually neutralized with a mixture of hydrochloric acid and organic acids.

The manner of introducing chemical preparations of the proper dosage into a sand bore depends largely upon how the well is equipped mechanically. In some cases, it is possible to pressure liquid preparations so that marked benefits are obtained in the drainage area back of the sand bore. Oil producing formations which have been segregated into zones by packers can often be treated to best advantage with heating units used in connection with a suitable cleaning fluid.

In most wells where the tubing is not seated on packers, suitable chemical preparations are delivered directly into the sand-bore through the casing, around tubing, and without removing the pumping equipment. After the producing zone or bore has been filled to about two-thirds its capacity, the oil flow line from the tubing is reconnected so as to discharge into the casing. The pump is started, and the fluid circulated through the well for eight to ten hours; afterwards, the flow line is disconnected and the residue pumped out.

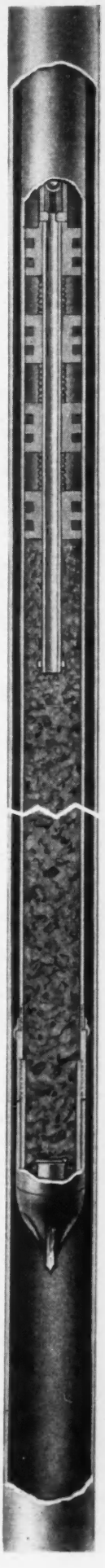
If the sludge condition is not cleared up after two or three circulatory treatments, spaced three days apart, and using a fresh supply of counter-agent each time, tubing and rods are removed and the sand-bore is swabbed. For this procedure, the initial practice in many cases is to deliver directly into the bore-cavity a combination of hydrochloric and organic acids, in 15 percent solutions, which are stirred into gasoline treated oil. The producing zone is filled from base to top, and the fluid is allowed to remain in contact with the sand-face for eight to ten hours before the swab is introduced. The purpose is to soften impacted residue, and to react chemically upon mineral deposits, silt, scale, etc, and especially upon the mud cake, which is a potent sludge forming factor in many wells.

Upon termination of the standing period, the spent acid solution and resultant residue are removed with the swab. With all follow-up runs, which should be continued as long as sludge is in evidence, the swabbing fluid is chlorinated water, or a solution of strong (dense) salt-brine. The swab is lowered into the bore, six to ten inches deeper with each run, until the base of the cavity is cleared. The completion process is a thorough washing down with chlorinated water.

The swab, even when used in shot-fractured bores, generally proves effective, not only in cleaning the sand face, but also in removing sludge from the openings of pores and channels for an appreciable distance back of the sand face. The latter result is due mainly to vacuum actions created within the bore as the swab is being pulled up through the casing.

Sludge Removal with Cleaning Tools

Where sand or formation bores are completely sludge-bound and badly



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impacted with sediment, the most practical procedure is to use clean out tools, which should include at least a stem, bits, bailer, sand pump, and a spray gun or fluid jetting device. After pumping equipment has been removed from the well, any remaining packers or packer seats which are smaller than the inside diameter of the casing must be drilled or fished out. With the annulus thus cleared of mechanical obstacles, as much oil as possible is bailed off the sediment in the bore, so as to avoid unnecessary emulsions. At the final run for this purpose, the bailer (sand) line is flagged or marked at the casing top, and measured as it is drawn from the hole. To that depth, approximately, the drill is introduced and started on the first run. The line is kept taut, so the bit "reaches" for bottom, and a very gradual penetration is made into the mass of sediment.

The drill, in a cleanout process, serves mainly as a stirring rod, and hasty, diving penetrations result almost invariably in a mudded-up sand face and a faulty elimination of sludge. Chlorinated water or brine is the cleaning fluid generally employed, and just enough fluid is used with each run to keep the stirred residue in good bailing condition. On densely coated bore faces, it is sometimes necessary to use a paraffin knife or bore-scraper along with the drill.

In the latter stages of a cable tool clean out, bore heaters, principally the small, compact electric units, are often beneficial in removing sludge crystals and wax from a sand face. Temperatures, ranging from 180° to 220° F., are built up in the sand bore fluids, and maintained for periods of 24 to 36 hours, after which resultant residues are bailed out.

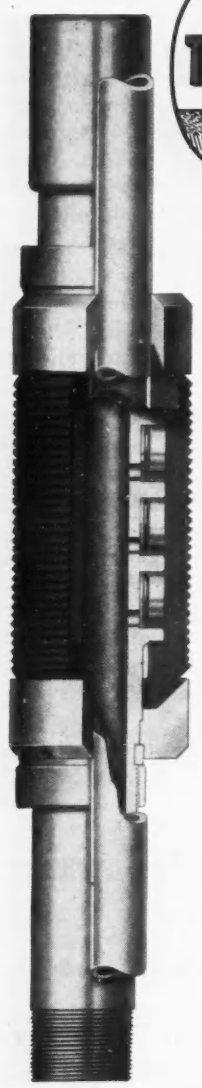
After the bore, including any annulus extension below the sand, has been cleared to its base, the oil producing zone is washed down several times, preferably with a spray gun or jetting device, loaded with cleaning fluid. While the bore is open, damaged casing, packers, etc., should be repaired or replaced, and all stretches of treacherous open hole above the oil producing horizon should be sprayed liberally with plastic compounds or cement slurry. Assuming that the pumping equipment has been cleaned in the meantime, the well is then tubed and made ready for production. Individual checkups, including inspection of the pumped oil, are made, however, at intervals of 90 days, during the succeeding year.

Sludge Prevention and Control

The objective in bore clearance is to remove sludge compounds which have accumulated from both the annulus and drainage system, and to provide space for similar compounds being conveyed continuously to the bore by the incoming oil. After fluid movement within the drainage system has been partially restored, an occasional bore washing with chlorinated water or a liquid wax solvent will generally condition the residue for its easy removal with the oil through the pumps.

When necessary, timed applications of carbon dioxide, sulfonic acid solutions, and certain other chemicals serve as wetting agents in releasing oil from channel openings around the sand face, and these preparations also tend to break up emulsions and water blocks which are pertinent factors in sludge formations.

An oil production increase, ranging from 15 to 85 percent, has been proved by case histories of stripper wells which were cleaned of sludge



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The Page Type "C" Tubing Anchor is designed specifically to anchor parallel strings in "Free Pump" installations. Its advantages to operators are many. The Page Type "C" Anchor *assures* a fast tubing run-in without danger of accidentally setting slips, *eliminates* the human element of top-hole manipulation in setting and *saves* valuable time in landing tubing strings. The Page Type "C" *relieves* tubing of fluid and working pressure loads and *increases* the factor of safety in long tubing strings. It enables running longer strings of second grade tubing because the Type "C" *supports* the tubing and holds it in tension, free of "working" loads.

SIMPLE OPERATION

The Page Type "C" Tubing Anchor sets hydraulically on fluid pressure differential. The hydrostatic head of oil in the power string together with the "free pump" surface operating pressure, forces a series of small pistons against v-cut slip segments that grip securely against the casing. Holding power of the slips far exceeds fluid head and operating pressure loads. Release and removal from well requires only drainage of tubing. Tool can be run-in either end up.

SIMPLE CONSTRUCTION

Anchor Body made from a solid billet of steel . . . working force consists of two v-cut slips and six pressure-sealed pistons . . . all parts replaceable and interchangeable.

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SURPLUS	21,500,000
*UNDIVIDED PROFITS	4,612,345
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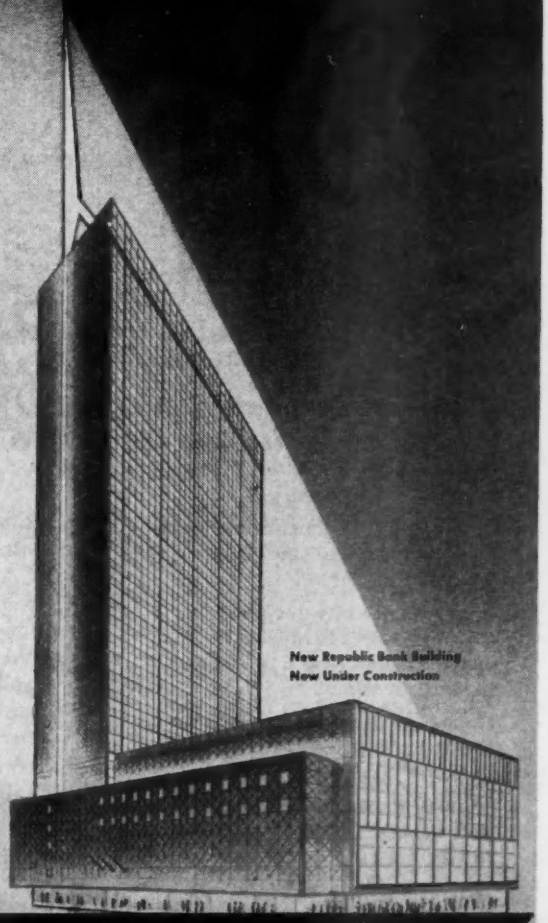

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Here are just a few of the "extras" that keep Coffing Safety-Pull Ratchet Lever Hoists on the job — and save on maintenance costs.

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- Sprocket and ratchet are special alloy drop-forged steel, heat-treated and ground.
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- All Safety-Pulls are factory-tested at twice their rated capacity.

Find out more about the hoists that stay on the job — and out of the repair shop. Write Dept. O4SP.

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compounds, the lowest percentage of increase being noted on wells where cleaning measures had been neglected or delayed for periods of 90 days or longer, after drainage impairment was first observed. Unfortunately, well histories also reveal and prove that drainage systems, severely damaged by sludge compounds, rarely, if ever regain their former status. Sludge segments which have located and congealed far back in the flow-channels and capillaries, or around the outer margins of a drainage radius, can not be eradicated, nor can oil from unaffected areas be pressured through such barriers.

Summary

Sludges, from a practical viewpoint, are emulsified sedimentary compounds which attain their greatest potency through variable behavior. To minimize resultant damage to a well or its drainage system, an oil recovery schedule should include three precautionary measures:

- Good engineering practices in bore completion and maintenance.
- Close observance of oil behavior, including frequent analysis.
- Early detection, and prompt removal of residue. Strict adherence to these measures generally results in free-pumping wells, presenting fewer layoffs and production problems. Lease operating efficiency is thereby increased and consequently, more oil is obtained in a given time at less expense.

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The complete editorial index covering all issues of WORLD OIL published during 1951 has been prepared and is bound separately in convenient pamphlet form. It will be sent free to all subscribers who write requesting copies.

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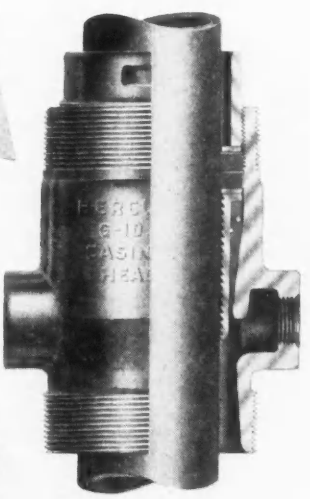

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Axelson "TLE" [Tubing Liner] Pump shown. There is an Axelson Deep Well Plunger Pump for every specific well condition.

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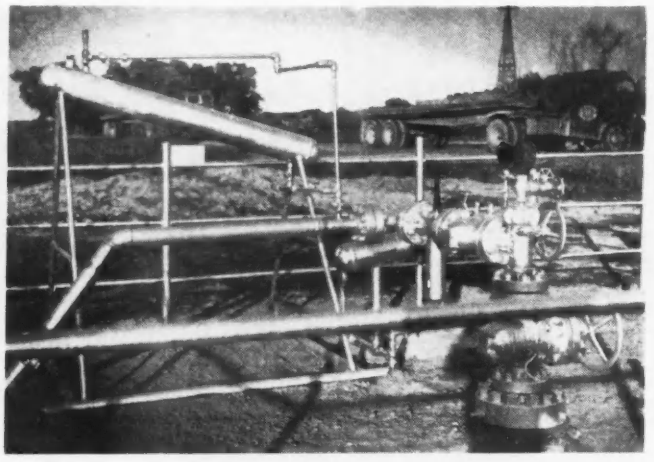
How to do it!

PRODUCTION HINTS

$10 is paid for each illustrated acceptable contribution. Mail to The Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas.

Chemical Gravitates Into High Pressure Well

Injection of corrosion inhibitor into a high-pressure gas-condensate well was simplified by using two gravity-feed units as illustrated. One unit fed the inhibitor into the flow line downstream of the choke, while the second allowed the inhibitor to drop into the casing annulus.



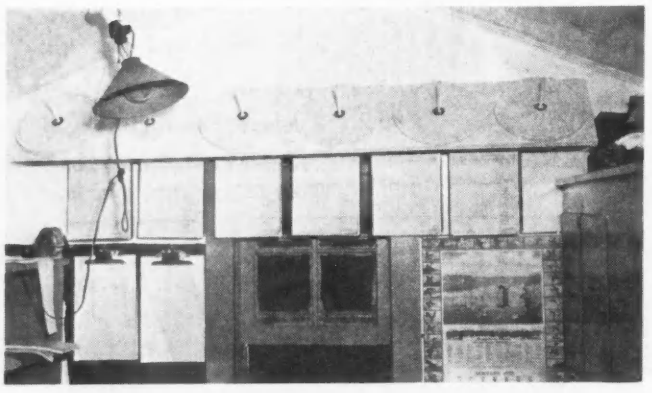
Storage chambers for the corrosion inhibitor chemicals were made of extra-heavy four-inch pipe sealed at both ends with a forged cap. Since the unit feeding chemicals into the flow line by gravity had to be above the point of entry into the flow stream, the chamber was elevated as shown. It was supported by four legs forming A-frames welded to skids so the unit could be moved easily. All fittings and piping were extra-heavy to handle the pressures involved. Each unit was made in a similar manner, the difference being in capacity. Since less inhibitor was placed in the casing annulus the unit connected to the casing was smaller than the unit feeding into the flow line.

The chamber was inclined about 20 degrees and the bottom connected to the flow line. This line contained two needle valves. One valve was located immediately below the storage chamber and the second in the riser welded into the flow line at the point where the chemicals were admitted to the flow line. An equalizing pressure line was connected from a tee in the chemical feed line described. It tied into the top of the chamber, and it was fitted with a needle valve. A fill plug was welded to the chamber so that chemicals could be poured in when needed.

By closing the valve at the flow line and at the bottom of the chamber, pressure could be bled down to atmospheric so the vessel could be filled. The vent valve was closed, the flow line feed valve opened, and line pressure applied on top of the liquid chemicals. With the pressure equalized through out the system, the valve below the chamber could be opened so chemicals would flow slowly into the flow line.

Chart Rack Preserves Gas Production Record

Gas measurement charts taken from recording orifice meters form a permanent record of the gas production from wells and leases, and it is desirable to preserve these charts as much as possible. Rather than cram these valuable records in desk drawers where they could become crumpled and soiled, they should be sorted and preserved on a neat rack such as the one illustrated.



The chart rack here is simply a ten-foot section of 1 x 12-inch lumber on which are short wooden pegs spaced so that the largest chart can be stored without overlapping adjacent charts. The rack, mounted high on the wall and out of the way, is slightly tilted away from the wall on which it hangs so that the charts lie flat. Two triangular wooden wedges serve this purpose.

Each peg on the board represents a specific record file, and corresponding charts are kept here until they are required elsewhere for computation and permanent storage. The rack shown is in the pumpers headquarters' office. Immediately below the chart rack are lease records filled out by each pumper.

EASY OPERATION under highest pressures-Proved by more than 31,000 Valves in Christmas Trees Installed

Heavy Duty Stem Thrust — The stem thrust is a rugged, heavy duty ball-bearing, and is permanently grease-packed to assure ease of operation. External location of the ball thrust bearing protects it from injury by corrosive well fluids. The valve can be repacked under pressure, and the ball race can be replaced without removing the valve from service.

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Oil — Water — Gas to 5000 pounds W P

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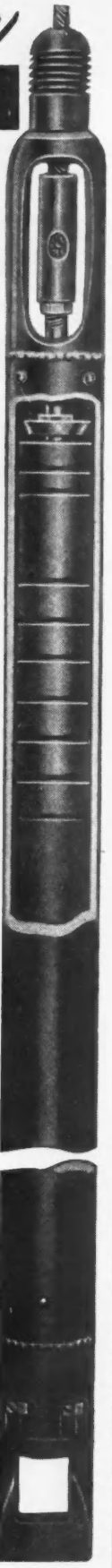
Miller SAND PUMPS



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The Miller Sand Pump is made in regular and heavy duty types in sizes listed below. Lug type, chisel, sand and bailer bottoms are easily interchanged.

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3"
3½"
4¼"
5"
5½"
7"

Lengths

20 feet
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Special Sizes and Lengths Made to Order!

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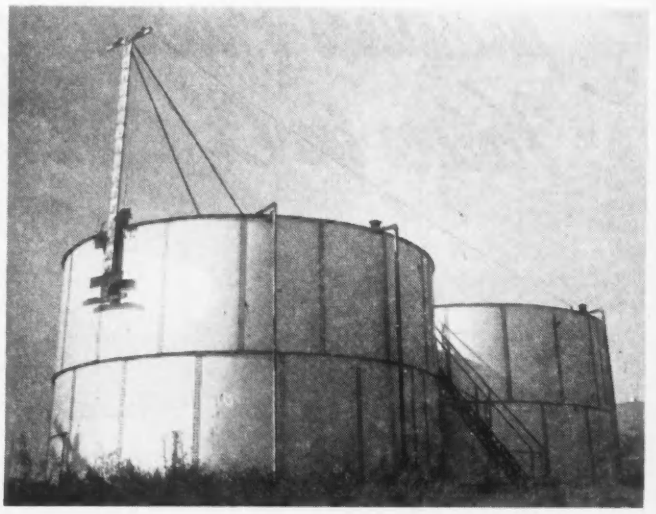
Gauge Indicates Level in Tank



Ingenuity of a farm boss and his crew enabled them to construct a makeshift gauge that indicated the water level in two 1500-barrel tanks. The gauge was made so that it could be read easily from a distance, thereby enabling the pumper to check the water tanks with a glance from his truck window.

The principle employed is an old one, having been used by the railroads for nearly a century. A weighted indicator slides up and down over the face of a calibrated rule. The indicater is suspended by a cable that passes over an elevated pulley and is then connected to a free-moving float inside the tank.

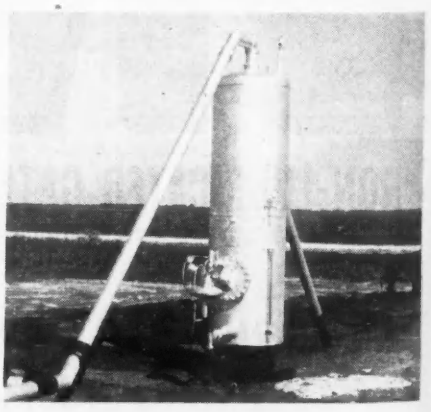
In this case, the calibrated scale consists of a piece of 2 x 12-inch timber propped up with two pipe legs that rest on the tank roof. A horizontal arm across the top of the board supports a pulley on each side. A piece of flexible cable supports a weighted pointer at one end, and a float at the other. In the case of the rear tank, the cable is extended to one side of the tank where a second pulley is anchored. In this way the cable can be deflected inside as in the case of the first tank.

The range of both indicators is similar in each tank, and the relative water level in each tank can be judged by looking at the two pointers. Very little new material is required, and since the installation is a temporary one, the water gauge device can be set up in short order.

Angle Approach Saves Fittings

Some pipe and fittings can be saved when setting up low-pressure separators by connecting the inlet line and the discharge line at an angle as illustrated. The separator installation shown handles considerable volumes of gas in relation to the liquid produced. It is operating on relatively low pressures, therefore no heavy-duty equipment was needed.

The three-inch inlet line is seen at right background and leads up to the separator at about a 45-degree angle. The gas outlet, connected to the top of the separator, also drops to ground level at an angle. In each case, it was necessary to make an angle weld on each line at ground level and at the connection into the separator. Some piping was eliminated by making the angle approach rather than extending the lines up to the separator base and connecting them into a riser.



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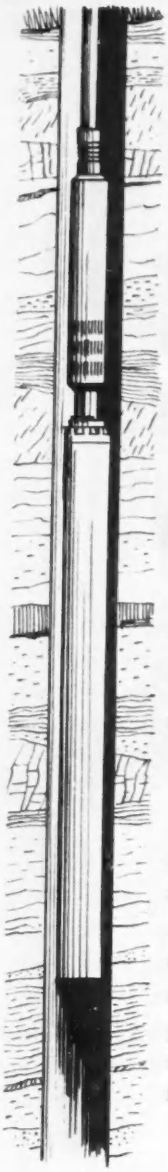
LOOK FOR THE GREEN RODS



THE BEST WAY TO *LOWER* OPERATING COSTS.... *LOWER* A **REDA** PUMP INTO YOUR WELL

With continually rising labor and investment costs, economy of operation is of paramount importance to operations producing wells with increasing oil-water ratios.

Reda pumps are given consideration as original or replacement equipment because of their known performance in producing fluid at a *lower* cost per barrel, and thus often extending the ultimate economic life of wells.

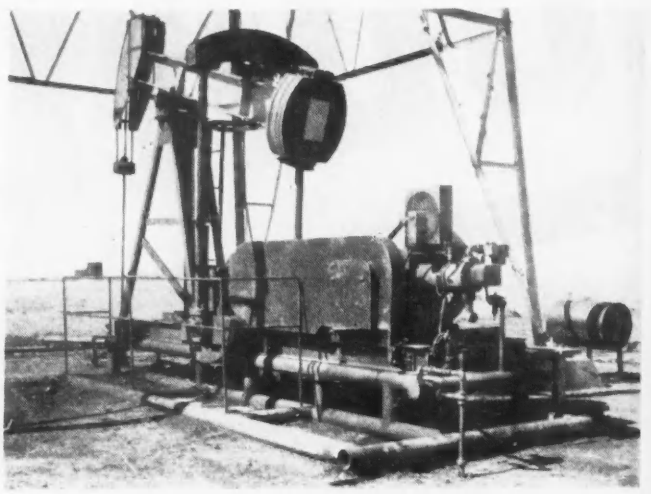
Improved engineering and design have increased operating life. Increased operating life means *lower* labor cost per barrel, *lower* investment cost per barrel, *lower* maintenance cost per barrel, *lower cost per barrel produced.*

REDA

PUMP COMPANY

BARTLESVILLE, OKLAHOMA

Pipe Used for Pump Foundation

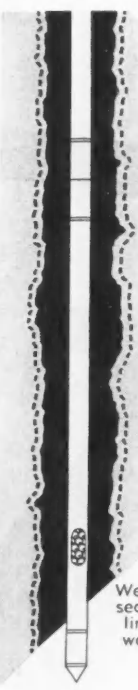


On edge wells which have a short life expectancy, a savings may be obtained by making a skid for the pumping unit. Then, when the well is abandoned, the entire unit can be easily moved to another well.

Welded from scraps of four-inch pipe, the skid is made along the pattern of the usual concrete foundation. A rectangular section is made to fit the bottom of the pumping unit, with a volume chamber built into the end away from the well head for the gas line. One-foot pieces of four-inch pipe are then welded to the base and another rectangular piece so that the unit will be the proper height from the ground to permit the crank to turn if all counterweights are necessary.

The base is wider than the unit foundation to provide proper bearing and make it unnecessary to use matting. An extra section is run out on the heavy side of the gear box, and the guard rails for the counterweights are welded to this section.

When a well is to be put on the pump, the entire unit is moved out after being prefabricated in the shop. All that is necessary for installation is to spot the unit, level it, and hook up the polish rod clamp and the fuel supply.



Well bore cross section. Dotted lines indicate wall reaming.

Clean Out Congested Wells

WITH BURCH AGATE TORPEDOES

Marble blasting pays because marble abrasion is thousands of times greater than sand blasting. It frees oil and gas in the well bore by removing all retarding substances from the true pay formation.

- CONDITIONS A WELL BORE OR SHOT HOLE BY RESTORING NATURAL FORMATION.
- ABRASION REAMING THE WALL CONTOUR DEEPER THAN RETARDMENT.
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- DESIRED COLUMN TO COVER PAY IN ONE RUNNING CAN BE MADE WITH 5' SECTIONS.

Cross section view of torpedo

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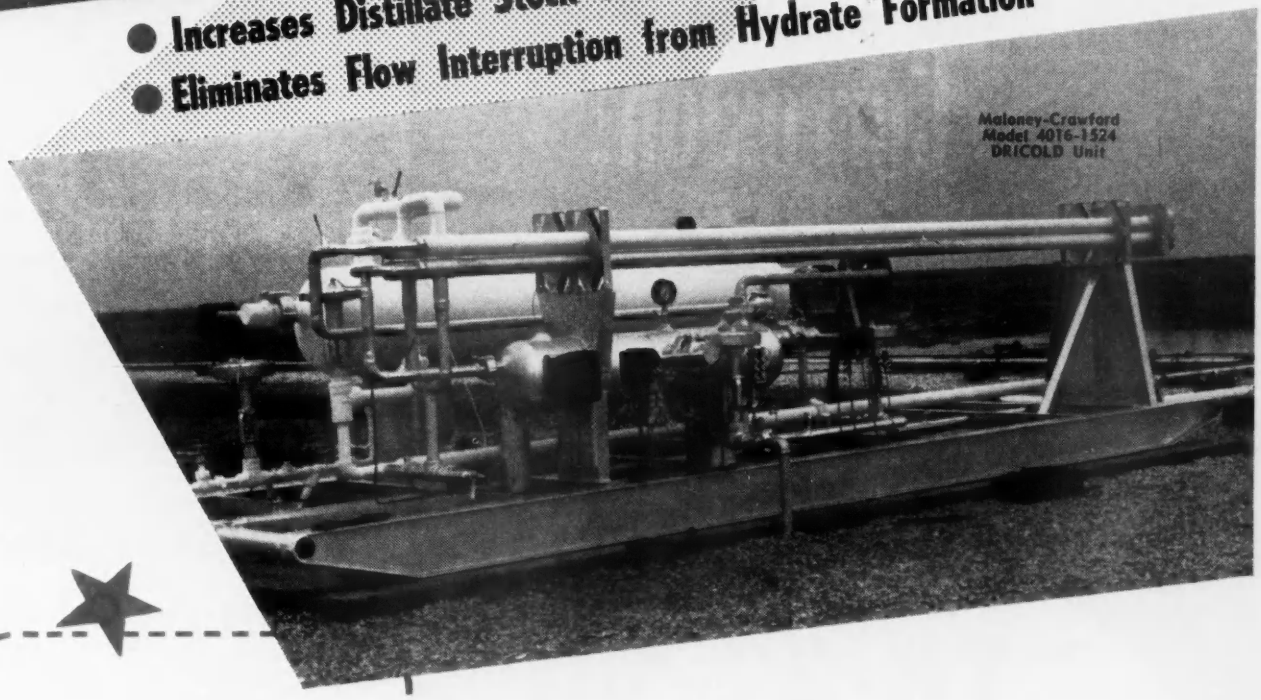
Now Field Proven
MALONEY-CRAWFORD DRICOLD UNIT

- **Increases Distillate Stock Tank Recovery 5 to 25%**
- **Eliminates Flow Interruption from Hydrate Formation**



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Maloney-Crawford's field tested DRICOLD Unit increases distillate stock tank recovery 5 to 25% by successfully using low temperature separation without flow interruption from hydrate formation.

The unit eliminates the need for such drying agents as the glycols and alumina.

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PETROLEUM EQUIPMENT SUPPLIERS ASSOCIATION MEMBER

TowerAvertsDamage To Marine Oil Well

A hazard for oil wells in bays and lakes is the possibility of collision with boats or barges at night or during storms. Piling is used to serve as a shield or bumper against boats striking the wellhead and flow lines. In the bay installation shown, six pilings have been driven in a circle around the well, and capped a few feet above average high water level. A circular metal plate fastened to each pile interlocks them for additional support.

A protective framework, extending above the tubing pressure gauge mounted on top of the christmas tree, was made of four-inch pipe and strap steel. Two circular rims joined by six sections of the pipe form a large drum framework. The lower rim is bolted to the ring attached to the piling so that the framework is firmly anchored. To the top of this frame is bolted a gin pole structure made of light galvanized angle iron.

Purpose of this elevated gin pole is twofold. It serves first as a support for pulleys when running tools and instruments into the well, and, secondly, on it can be mounted red lights as navigation aids. When it is necessary to pull the well with a small barge rig, the entire assembly can be removed by merely unbolting the framework from the piling ring.

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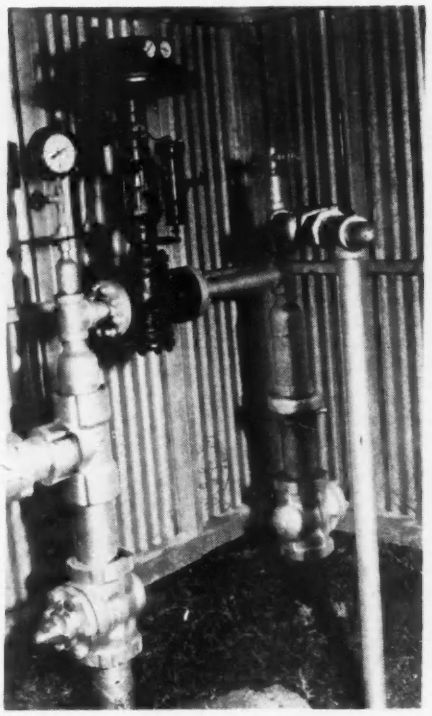
Pressure Relief Simplified

A pressure relief valve on the discharge line must be provided when gas pressure is supplied by a compressor station to gas-lift a considerable number of wells. In fields where excess gas is produced and sold to transmission lines, the example illustrated is a satisfactory way to handle the pressure relief problem of the gas-lift system.

Shown are two three-inch risers extending out of the ground about two feet. The riser on the left taps an underground line, connected to the compressor discharge system, which provides gas at pressures of about 750 pounds. The riser at right is connected to a sales gas line, which is parallel to the gas-lift supply line. Both lines lead to a metering station where the volume of gas sold and the volume used for gas-lift are measured.



In anticipation of times when the amount of gas taken by the gas-lift system drops so that pressure in the compressor discharge line becomes excessive, a pressure relief valve was connected across the two risers. This valve makes it possible to pop gas over into the sales line, which operates at a slightly lower pressure. The pressure relief valve is actually a regulator, set at 750 pounds; however, it will not open if the sales line pressure is as great as 750 pounds.

The two-inch line connected into the top of the riser and above the regulator connection goes below ground and to the compressor suction. If, for any reason, a large number of the gas lift wells are shut in and a relatively small volume of gas-lift gas is used, this bypass line can be opened and some gas circulated back to the compressor suction until conditions return to normal. The tee on the gas-lift system riser carries gas to another meter line to supply gas-lift gas for a separate lease.

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When you invest your money you want a product that will do more for you—whether you're buying a pipe wrench or a pumping unit.

If it is a pumping unit you want—get a JENSEN! Jensen's are made to last and to operate at lower cost *for you*, Jensen's incorporate a design proved through 30 years of rugged field service; precision shaved gears; anti-friction bearings; oil bath lubrication.

Drop us a card or letter for specifications and prices.

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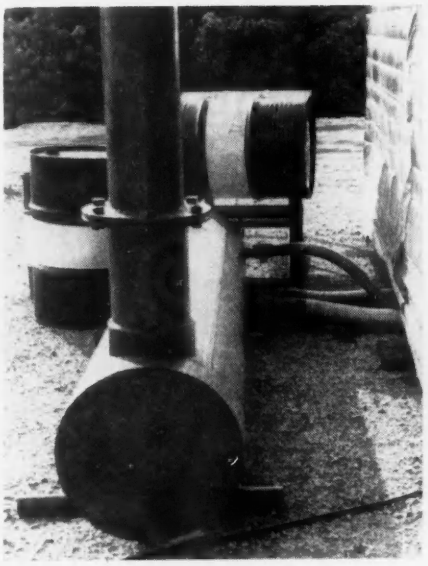
BROS. MFG. CO., INC., COFFEYVILLE, KAN.

EXPORT OFFICE: 50 CHURCH ST., NEW YORK CITY



Shop-Made Muffler Quiets Engine Noise

Where production facilities are near residential areas, it is sometimes necessary to reduce engine exhaust noise to a minimum. Here is a shop-made chamber that handles the exhaust from three auxiliary engines housed in the building nearby.

The outward appearance of this exhaust noise reducer is that of a horizontal heater equipped with a stack. Illustrated is part of the unit, showing the horizontal chamber, the flanged stack connection and the flexible exhaust lines connected to the engines inside the building.

Made of plate steel and welded to form a chamber measuring about 20 inches in diameter by 12 feet long, both ends of the device were welded closed as shown. Exhaust connections at the far end were provided by welding the proper size nipple to the vessel and equipping these nipples with unions that can be quickly connected to the flexible exhaust line.

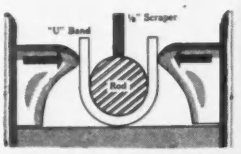
The noise exhausting from the chamber is carried above ground by a stack made from salvaged line pipe or casing. It extends into the air about 14 feet and is fitted with a rain cover to prevent entry of moisture. The stack has been flanged near the bottom end to facilitate moving, for the base of the stack is welded to the chamber, and it would be bulky to transport as one piece.

Such exhaust chambers could be made for any number of small horsepower engines which are reasonably near each other.

NO PARAFFIN TOO HEAVY

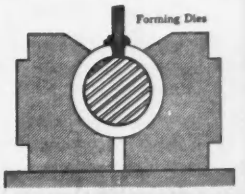
TO WHIP CRALL SPIRAL SCRAPERS

CRALL Spiral Paraffin Scrapers will keep any well free from paraffin. Even in areas where paraffin is unusually heavy, CRALL Spiral Scrapers keep the well cleaned efficiently. Save work-over servicing and stripping jobs, with CRALL Scrapers and you'll be time, man power and money ahead every time.



Cross section showing "U" band being die-formed around rod to the scraper blades.

PASS SCRAPERS EVERY STROKE UP AND DOWN



Cross section showing band held under pressure around rod while ends of band are shrink-grip attached to scraper blade.

- Scrapers alternate—one right, one left—eliminating tendency of the rod to unscrew.
- Scrapers are attached at our fabricating plants and stocked at supply stores.
- Made of thick, mild steel. Sizes to fit 2" and 2½" tubing. Will fit any make of sucker rod. New or used.
- Scrapers are light in weight. The extra load to your rod string is negligible, 150 to 160 lbs. per 1,000 ft.

- No gadgets to fool with. No maintenance cost. Scrapers will not harm rods or tubing.
- Scrapers are placed close enough so they pass or meet each other with each reciprocation up and down.
- Scrapers fit perfectly. Neither scrapers nor bands are welded to the sucker rod.
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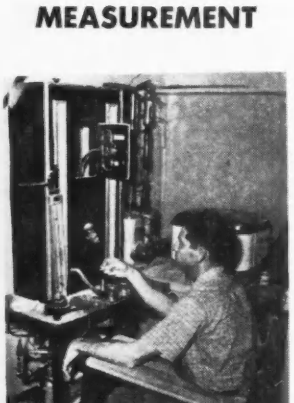

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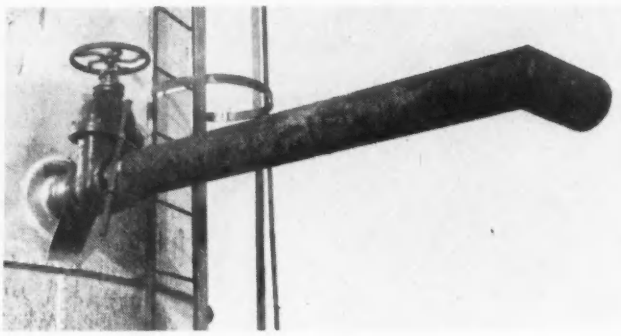
Handle Aids in Turning Spout



To simplify handling the filling spout during the loading of tank trucks, an operator in the Lone Rock heavy oil producing area in western Saskatchewan equips each spout with a handle which facilitates turning the large pipe.

The handle consists of a round steel bar welded across the top of the pipe a few inches from where it enters the gate valve. The bar is further secured by means of a round bar yoke which is wrapped around the under side of the pipe.

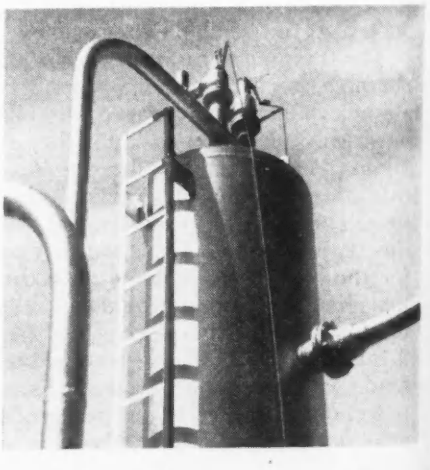
The heavy oil producing fields in this and other parts of the Lloydminster area are not served with pipe lines and oil is trucked to market in tank trucks. Lease tanks are equipped with loading facilities. To prevent unnecessary dripping of oil from the spout between loadings, operators often equip the spouts with a 45- or 90-degree elbow, which is turned upward after a truck is loaded out, hence the need for some way of providing leverage to facilitate turning the pipe. In this installation, the lease tank is a three-ring, 750-barrel tank. The bottom ring is used as a sump in which water and sand can settle out. The loading spout is taken off near bottom of the second ring.

Hand Line Used in Valve Tests

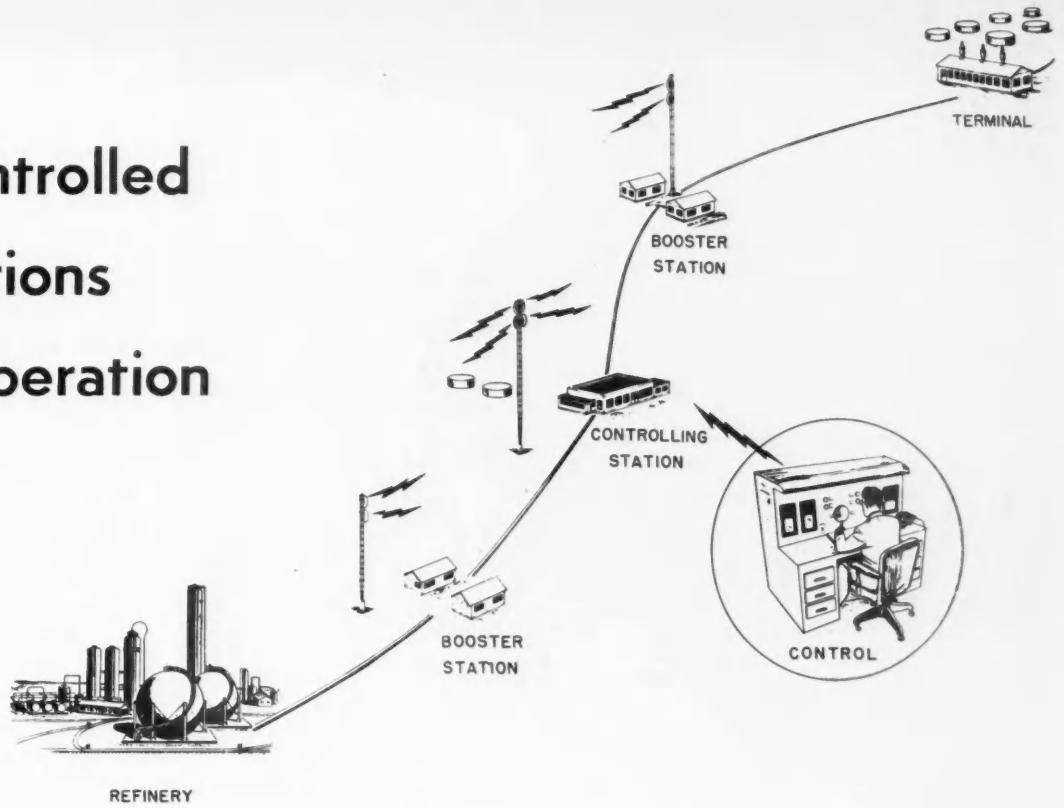
On high-pressure separators, or any high-pressure vessel for that matter, it is essential that the safety pressure-relief valve function when pressures become excessive. Because it is seldom that such valves are needed to release this excessive pressure, it has become standard practice to check the functioning of the valves by manual release.

Two such pressure-release valves were mounted on top of the high-pressure separator shown. Instead of having to climb the ladder and manually pull the release handle, the pumper installed a hand line attached to the valve so that he could check the valve when standing on the ground. In this way he didn't have to climb on top of the separator, and he was at a safe distance from the roar of escaping gas.

To provide the necessary angle of pull on the release handle, a 45-degree angle brace was added to the top of the separator. This was merely a short section of sucker rod to the end of which was welded a small brass pulley. The hand line was threaded through the pulley and the free end anchored at the base of the separator where the pumper could easily grab it.



First Radio-Controlled Pump Stations Now in Operation



By C. H. HOHNADEL

Project Engineer, Refinery Engineering Company, Tulsa

THREE micro-wave-controlled booster pump stations now operating in southern Oklahoma were installed for Sunray Oil Corporation to step up the capacity of its six-inch oil products line between the Allen and Sunray (Duncan) refineries.

The main control points are at Wynnewood and Allen. The Wynnewood station contains two complete sets of microwave equipment and controls pump station 41-A located 19½ miles southwest of Wynnewood and station 42-A, 24 miles northwest of Wynnewood. Station 1-A is controlled at Allen with the remote control station located approximately 31 miles north. This station is very similar to the first and incorporates the same type of equipment.

The microwave equipment used is the 950 to 960 megacycle system utilizing three channels to carry voice, remote control and supervisory control functions.

The radio relay links provide for the remote control of these pumping stations and will relay from the remotely controlled station to the main control point the following functions:

- Suction pressure.
- Discharge pressure.
- Kilowatts of power.
- Pumping equipment failure.
- Operation of emergency power.
- Tower light failure.

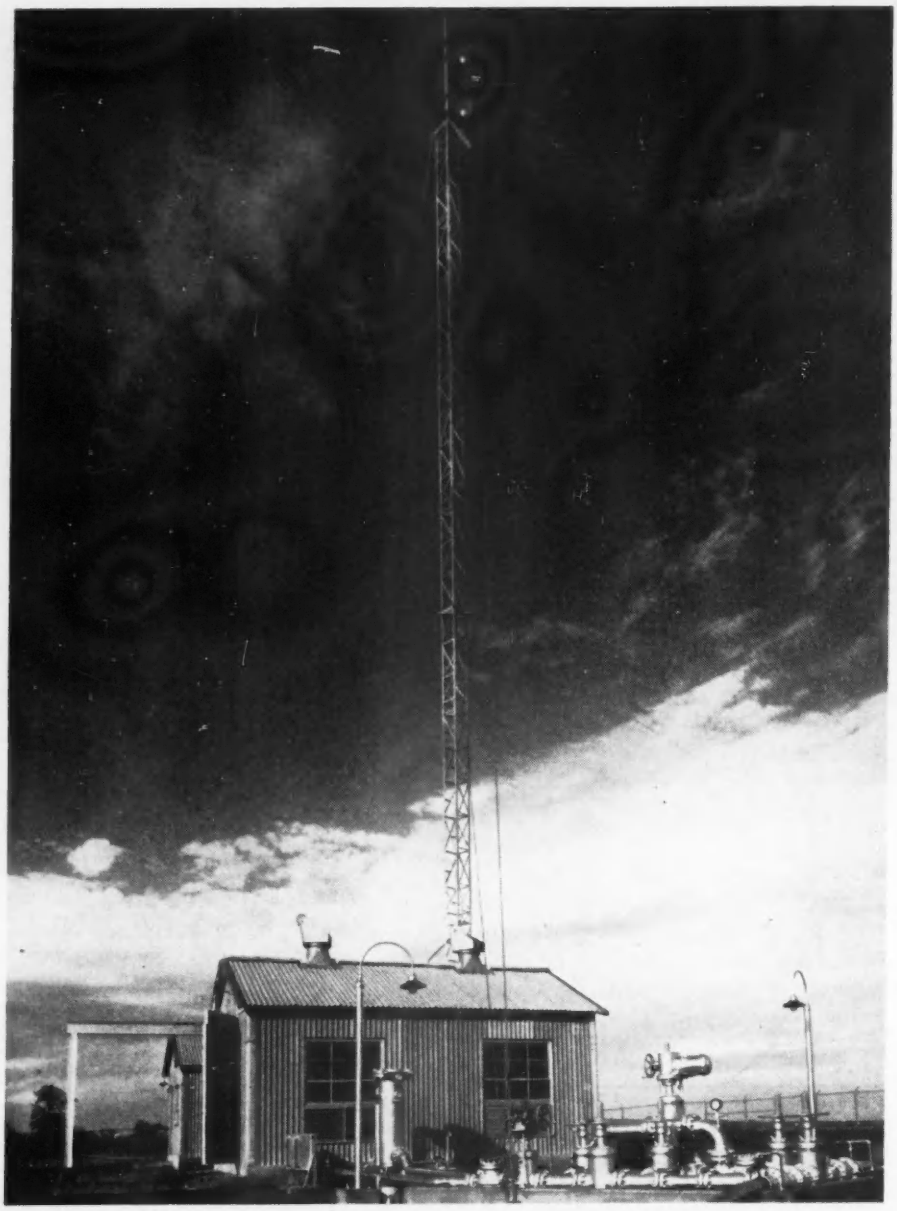
TWO MICROWAVE-controlled automatic pump stations have begun operations. Radio equipment at a "mother" remotely controls suction pressure, discharge pressure, operation of emergency power and shutdown equipment, while radio equipment at each automatic station telemeters information and provides means of monitoring operations at central location.

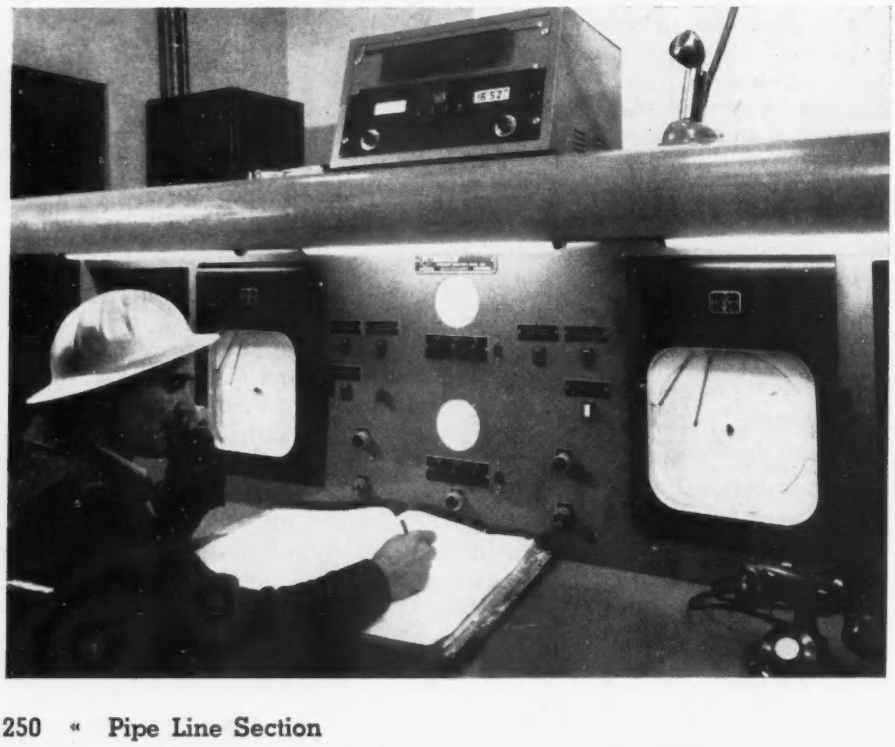
The radio relay links also provide two-way voice communication channels. The antenna arrangement for the first leg of the system consists of sending and receiving antennas at remote pump stations 41-A and 42-A, which are mounted ten feet apart vertically on the same towers. Likewise, at the Wynnewood control point receiving and transmitting antennas are ten feet apart and mounted vertically. One set points toward 42-A and the other toward 41-A. All antennas are of the parabolic reflector type, the elevations of which were determined by the terrain and the desire to connect both legs of the system in the future without modification expense of towers, transmission lines, or antennas.

Both portions of the system have been designed so that expansion of either or both can be accomplished by the simple addition of channeling equipment and without the scrapping of equipment already instealled.

PUMPING EQUIPMENT: Multistage centrifugal pipe line pumps with a 500 horsepower explosion proof electric motor are used at pump stations 41-A and 42-A. Pump station 1-A is equipped with multistage centrifugal pipe line pump with a 700 hp explosion proof electric motor.

Design features include a horizontal





split case of small diameter and symmetrical form; defuser type construction for perfect radial balance; double renewable wearing rings; renewable floating pressure breakdown bushings; deep packing boxes with large jackets; split type glands; ring oiled ball bearings in jacketed housings; rigid concentrically ground shaft sleeves, sealed at inner end and extended through the gland; and enclosed type impellers dynamically balanced and arranged back to back in groups of two, three or four. The one interstage crossover and suction and discharge nozzles are cast integral with the lower half of the case.

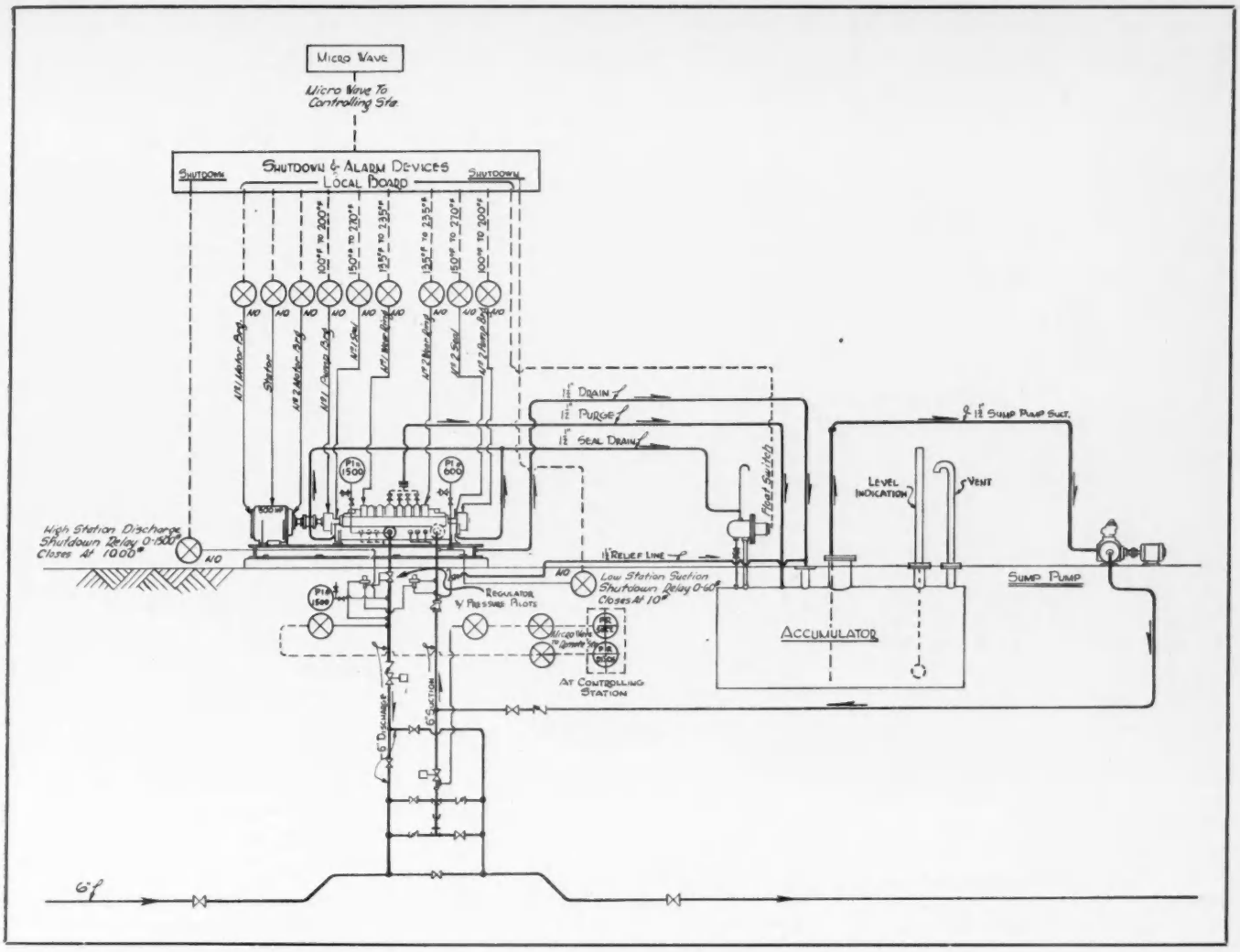
Pumping Equipment

PUMP HOUSE: The pumping equipment is housed in a steel-frame corrugated transite covered building, equipped with a three-ton monorail extending ten feet beyond the building to a supporting "A" frame. Windows are glazed with one-fourth-inch explosion resistant, fire-retarding semi-opaque glass. The concrete floor is topped with a one-eighth-inch coat of non-sparking compound to reduce the hazard of sparking and static buildup. The pump building is ventilated, and the ambient temperature controlled by the use of screened adjustable louvers and large revolving roof ventilators. Double doors at each end of the building are provided for easy access of the pumping unit.

CONTROL HOUSE: The control build houses the panel and the microwave supervisory sending and receiving equipment, and like the pump building is a steel frame, corrugated transite covered building, with one-eighth-inch glazed windows and adjustable louvers with roof ventilators for controlling building temperatures. The floor is concrete and the panel, along with the microwave and allied equipment, is set along one wall with a four-foot passage behind the panel and with access doors at either end. The building is large enough to allow eight feet of clear space in front of

(TOP) Microwave controlled booster station showing 170-foot tower with antenna on top including the two "dishes," one of which receives and the other transmits signals between the dispatcher and the remote station.

(BOTTOM) Operator at the control console in the Wynnewood station. Microphone and unit (at top) are used for voice transmission between the mobile field equipment and the dispatching office, enabling the dispatcher to contact all mobile field equipment.



Schematic drawing of radio-controlled pump station.

the panel running the length of the building.

STATION PIPING: The station piping consists of a manifold at the main line with the suction and discharge lines running above ground. Both lines enter and leave the pump house in trenches which allows for maximum room around the pumping unit. The manifold at the main line is so designed that the flow may be reversed to alloy charging stock to be pumped at will from the Allen refinery back to the Duncan refinery. The main gates on the suction and discharge lines are opened and closed with electric operators, remotely operated or with a clutch arrangement built into the controller. Station flow is regulated with a line pressure operated valve in the discharge line with low suction and high discharge pilots to regulate pressures. Since this valve is automatic in action and line pressure controlled, it will be possibe to vary the product pumped without fear of upsetting the hydraulic balance of the line.

A 1000-gallon underground sump tank is provided alongside the pump building. This sump is used to collect product when bleeding the pump (initial start only), pump drains, and mechanical seal leakage. The sump is equipped with an automatic seal leakage indicator which, in the event of excessive seal leakage, will close down the station. This indicator may be adjusted for whatever flow may be considered excessive. A sump pump in the pump house will be used to return the product collected in the sump to the suction line whenever the sump gauge indicates a full tank.

Control Equipment

EQUIPMENT: The panel at the controlled station consists of two 2 hp, 208-volt, 3-phase, 60-cycle combination reversing starters; one 3 hp, 208-volt, 3-phase, 60-cycle combination starter; one 500 hp, 2300-volt, 3-phase, 60-cycle starter; fused disconnects for 2300-volt line to the 10 KVA transformer; one 120/208-volt lighting panel; one 10 KVA, 2300-volt, 120/208-volt, 3-phase transformer; one automatic transfer panel; one 12-drop manual reset annunciator; one wattmeter transmitter; phone hand set and voice receiver; start-stop push button for local control; selector switch, and necessary relays and switches. A suction pressure 0#-500# transmitter and discharge pressure 0#-1200# transmitter, both mounted in separate explosion proof housings, are mounted remote from the controlled station panel.

The station consists primarily of a 500 hp, 2300-volt, 3-phase, 60-cycle motor driven pump, two 2 hp, 208-volt, 3-phase, 60-cycle motor operated valves, and a 3 hp, 208-volt 3-phase, 60-cycle sump pump. Each valve motor has four internal limit switches for control purposes. One valve will be used for the discharge line and one valve for the suction line.

STATION CONTROL (Normal): The station will normally be controlled remotely by microwave equipment from the controlling station; however, local control can also be obtained by means of a selector switch located at the controlled station.

Starting the station is accomplished

by pushing the start button at the controlling station or a start button at the controlled station dependent upon the position of the selector switch. A 110-volt relay at the controlled station is closed either by microwave carrier impulse from the controlling station pushbutton or by the manually operated pushbutton at the controlled station.

In starting the station the following sequence occurs:

- The motor operated suction valve opens.
- When the suction valve is completely open the main pump motor starts and simultaneously the discharge valve starts to open.

To stop the station the stop button is pressed at the controlling station or at the controlled station, dependent upon the position of the selector switch. The pump motor stops simultaneously as the discharge valve starts to close. When the discharge valve is completely closed the suction valve begins to close.

The sump pump motor is operated manually from the controlled station by a start-stop push button without interlocks. There is no provision for emergency power for the sump pump.

Abnormal Operating Conditions and Emergency Shutdown

If either suction or discharge valve does not open completely the station will automatically shut down. If the operating suction pressure is not above a predetermined minimum or if the discharge pressure is not below a predetermined maximum, the station will also shut down, causing the discharge and suction valves to close in normal sequence. In case of abnormal pressure the station can be started again by pushing the start button at the controlling station or at the controlled station as soon as the pressure becomes normal. High pump case pressure will also cause shutdown of the station.

High temperature on pump bearings, pump case wear rings, pump seals motor bearings, and motor stator will shut down the station. Excessive pump seal leakage will trip a float switch on the sump tank, also causing shut down. Any of these troubles will be indicated by a red light on the console at the controlling station and a drop flag annunciator at the controlled station. The difficulty must be corrected and a mechanically interlocked relay manually tripped before the station can be set in operation again.

In case of power failure an automatic transfer panel cuts in an emergency 10 KVA, 12-/208 volt generator. This generator supplies power for the 12-/208-volt lighting panel and the two motor valves. If the station has power failure during the start-up, normal operation, or shut down, the wattmeter on the console will register zero and the emergency generator will supply voltage for normal sequence of closing the motor valves. When normal power resumes the station can be started by pushing the start button at the controlling station or controlled station. If the emergency generator fails to operate the indicator light marked "Emergency Generator Running" will not light on the console. When this condition exists the motor valves must be closed manually before the station can be started under normal power operation. Any cause for shutdown must automatically close the valves in normal sequence.

ELECTRICAL POWER: The 2300-volt line to the 500 hp pump and the 10 KVA transformer is supplied from the main substation.

The 10 KVA, 2300/120/208-volt transformer furnishes power for the sump pump motor, a 120/208-volt lighting panel, and the two-valve motors.

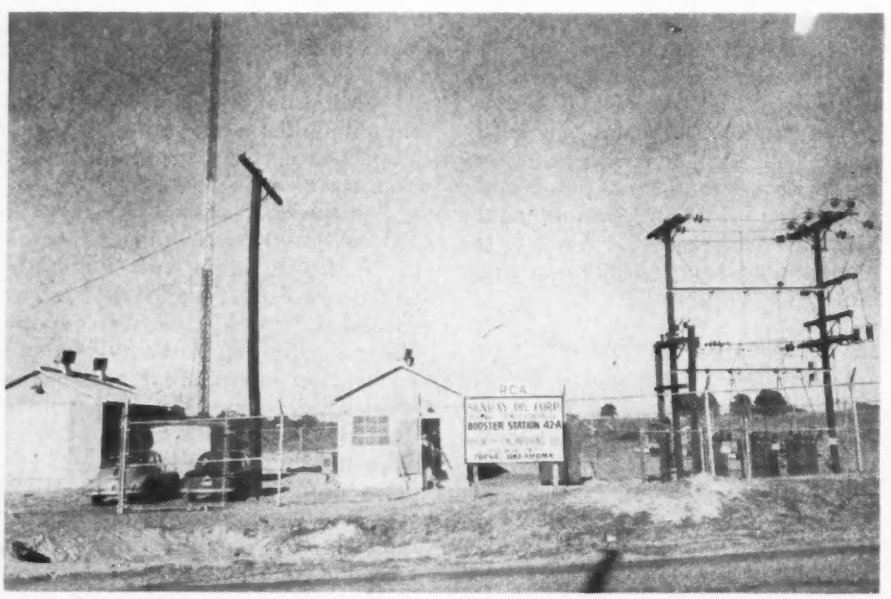
The lighting panel furnishes power for the temperature switches on the motor and the pump, float switch on the sump tank, microwave equipment, suction pressure transmitter, discharge transmitter and wattmeter transmitter.

PROTECTIVE DEVICES: Fused disconnects are supplied in the 2300-volt line to the 10 KVA transformer.

Undervoltage, overcurrent and shortcircuit protection is provided in all other circuits.

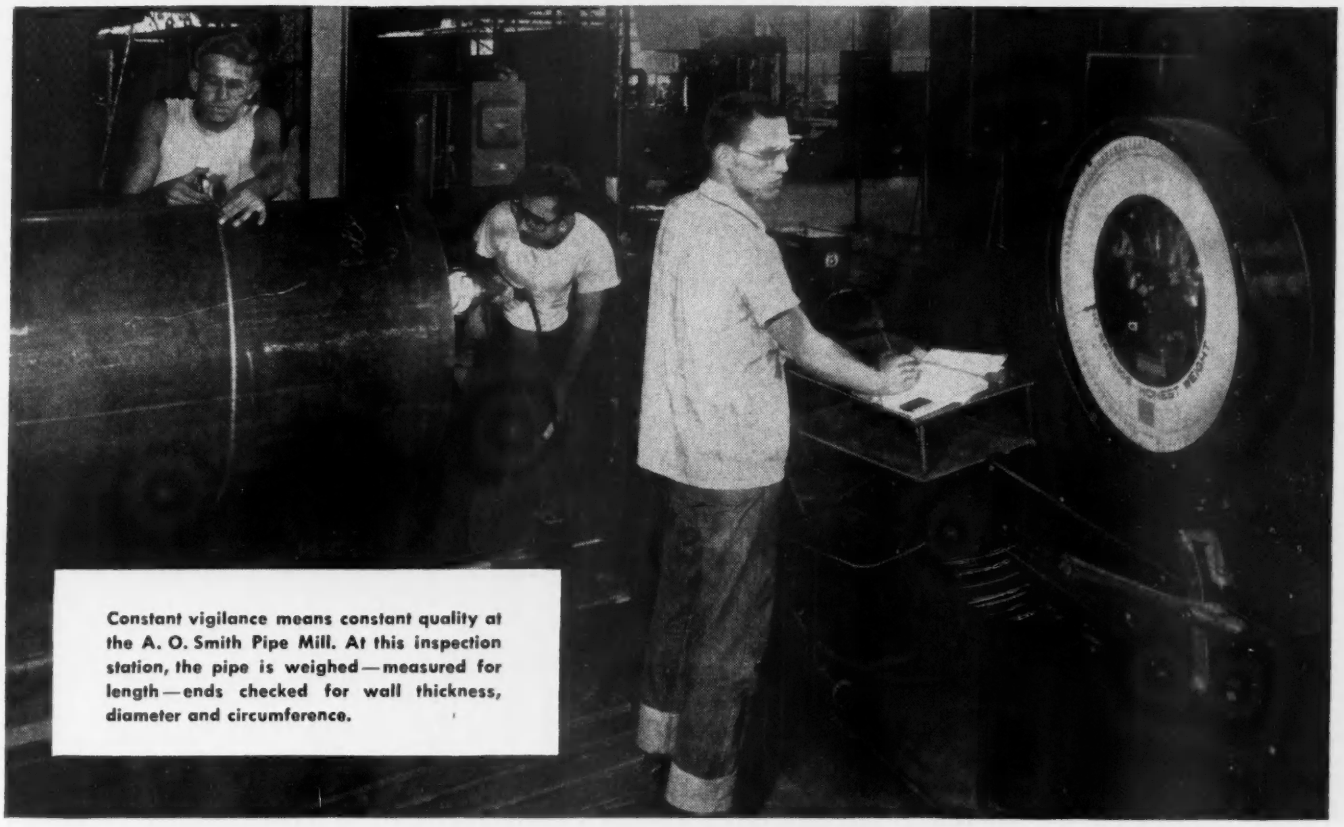
STATION CONTROL: Control of Station 41-A and Station 42-A consists of a specially built desk-type console at Wynnewood. The console includes recording instruments for suction pressure and discharge, visual indication of kilowatts, indicating red light for emergency shutdown alarms, amber light for emergency generator running, blue light for tower light failure, and white light for console power. A special handset phone allows the dispatcher to be in contact with field and station personnel if required. The drawer space and large work area of the desk allow the dispatcher to continue normal duties and at the same time, with a glance at the recording instruments, know the exact operating condition of the line. He will be able, at all times, to direct pumping requirements and adjust discharge pressures at the various stations through the medium of microwave.

Station 1-A control is directed from a special console at Allen. Instrumentation, light indication and voice channel for communications are identical with the console located at Wynnewood. Future expansion would allow these consoles to be located at a remote point for control of additional equipment by a simple addition of additional channeling equipment without changes to existing facilities.



Sunray Oil Corporation's Station 42-A (looking north), located 24 miles northwest of Wynnewood, Okla. At left is the 330-foot microwave tower which relays functions to the control station at Wynnewood. At right is substation which handles 2300-volt power to main pump motor, lighting panel and allied equipment.

FIRST names in pipelines depend on the FIRST* name in line pipe



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Pipe Line Maintenance Requires Organization

By H. M. McDONALD
Pipe Line Superintendent
Texas Eastern Transmission Corporation
Shreveport

A bulldozer and dragline strip cover from pipe line so crews can perform routine maintenance.

THE KEYNOTE of pipe line maintenance is organization. Crews must be organized and equipped to go into immediate action when the expected "unexpected" problems arise. Without supervision from home office personnel, each crew must deal with problems ranging from growing grass on barren right-of-way to minimizing damage from blowout or explosion.

WELL equipped crews every 100 miles along the pipe line and each with clear-cut responsibilities can simplify the complex task of maintaining a big-inch line. This is the theory Texas Eastern Transmission Corporation works on.

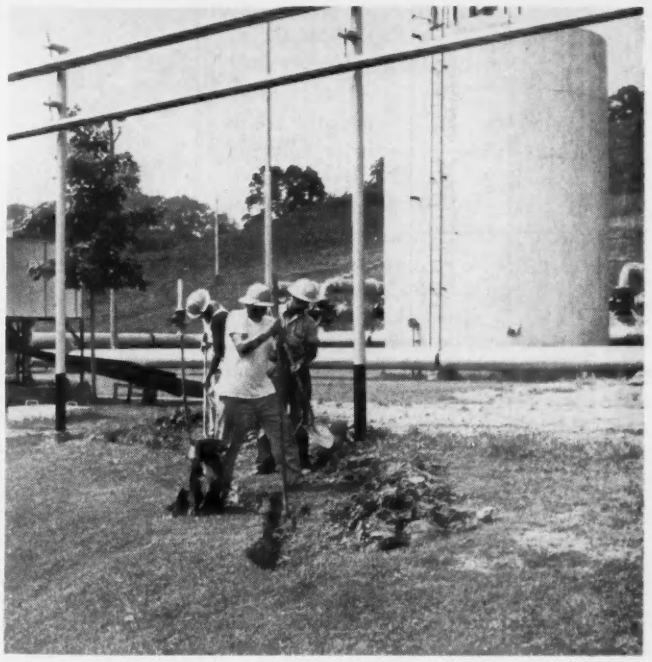
Texas Eastern maintains 2906 miles of right-of-way. A large percent of the company's pipe lines consists of dual or looped lines; therefore, the miles of right-of-way are considerably less than the miles of pipe line. Right-of-way classifications are identical with those set up for the company's pipe lines.

Five operating divisions, each headed by a division manager, control the field operations of the company. For maintenance purposes, these five divisions are subdivided into sections with a foreman in charge of each. Eleven foremen cover the entire system, two foremen each in four divisions, and three in the remaining division.

No rule of thumb method was used to determine the amount of right-of-way assigned to each foreman, although there is one crew, for approximately every 100 miles. Factors other than mileage were considered in designating maintenance areas are: terrain of right-of-way, number of purchase or delivery points, number of operating stations and locations where past experience had shown the necessity for frequent maintenance work. Accessibility of the pipe line from existing roads and highways was another important factor.

Problems of terrain were of primary importance. Each type of terrain presents an individual maintenance problem calling for different methods and equipment. In some southern areas, much right-of-way is through rice farms or swamp lands, which make it almost impossible to have access to the right-of-way during the summer months. In other sections, there are heavily wooded areas with few good roads and even fewer bridges over which heavily loaded

A maintenance crew lowers a line running through a southern rice field.



Small line relocation is routine work for these pipeliners.

trucks or heavy equipment can be moved.

Farther north, the line passes through areas where coal strip mines are numerous. A constant program of line locations must be carried on in cooperation with strip mine operations to insure the lines against possible damage. The pipe line crosses mountains in which landslides are common and close attention is required to prevent washes on the right-of-way. In the same mountainous area there is a large amount of subsurface coal mining. Constant cooperation between mine owners and pipe line companies is required to prevent areas of the land surface from settling and placing undue strains on the pipe lines.

A constant watch is maintained on the pipe line by patrol planes flying the system once a week. If a maintenance or repair problem is observed from the air, radio contact is made with the crew or foreman in that area and an immediate investigation is made. If the patrol pilot cannot contact a radio unit, a note is dropped at the nearest compressor station, and the information is relayed to the division office, which is in close contact with all maintenance crews.

The responsibilities of Texas Eastern's foremen are complex and exacting. They range from the unexciting job of right-of-way clearing to the more interesting tasks of rearranging station yard piping and general pipe line construction. Right-of-way maintenance involves cutting brush, mowing the right-of-way, maintaining fences, stopping washes, keeping road crossing markers, painting and servicing above ground valves and installations as well as keeping post signs painted.

New programs of highway repair and construction have made it necessary for pipe line companies to lower and case many of their lines. On Texas Eastern's pipe lines, all casing and lowering requirements are fulfilled by maintenance crews. This type of work requires a large portion of maintenance time.

Any work on a line under pressure is performed by Texas Eastern welders and crews. Taps are often required for purchase or sales points, additional valve installations and taps for cross-overs, blowoffs, etc. Bank erosion must be constantly checked at River Crossings to prevent the pipe line from being suspended in mid-air. In the past, it has been necessary for maintenance crews to install sheet pil-

Foreman John Webber inspects caked mud of river bottom before starting maintenance project.

Two pipe line maintenance men erect a small sheet metal building at a station site.

ing, sand bag or rip-rap riverbanks. In some instances, it has been necessary to lower the lines to prevent damage.

Maintenance crews devote some time to cleaning lines internally by running scrapers in the gas stream. Considerable time is devoted to terracing and seeding washes along the right-of-way. When erosion prevention becomes necessary, the landowner concerned is consulted, and the crews follow his wishes in terrace design and type of cover to be planted. Foremen and crew foremen are the direct contact men in Texas Eastern's good neighbor policy toward landowners along the lines.

The type of equipment necessary for proper maintenance of a pipe line depends upon the diameter of pipe involved, accessibility of the right-of-way and terrain and soil conditions. The equipment of each Texas Eastern foreman is designed to achieve maximum usage at greatest economy.

Texas Eastern foremen have at their disposal heavy equipment such as draglines and bulldozers as well as specialized tools essential to pipe line maintenance. Each crew is equipped with all necessary hand tools including track jacks, hammers, wrenches, shovels, grease guns and other normal tool box items.

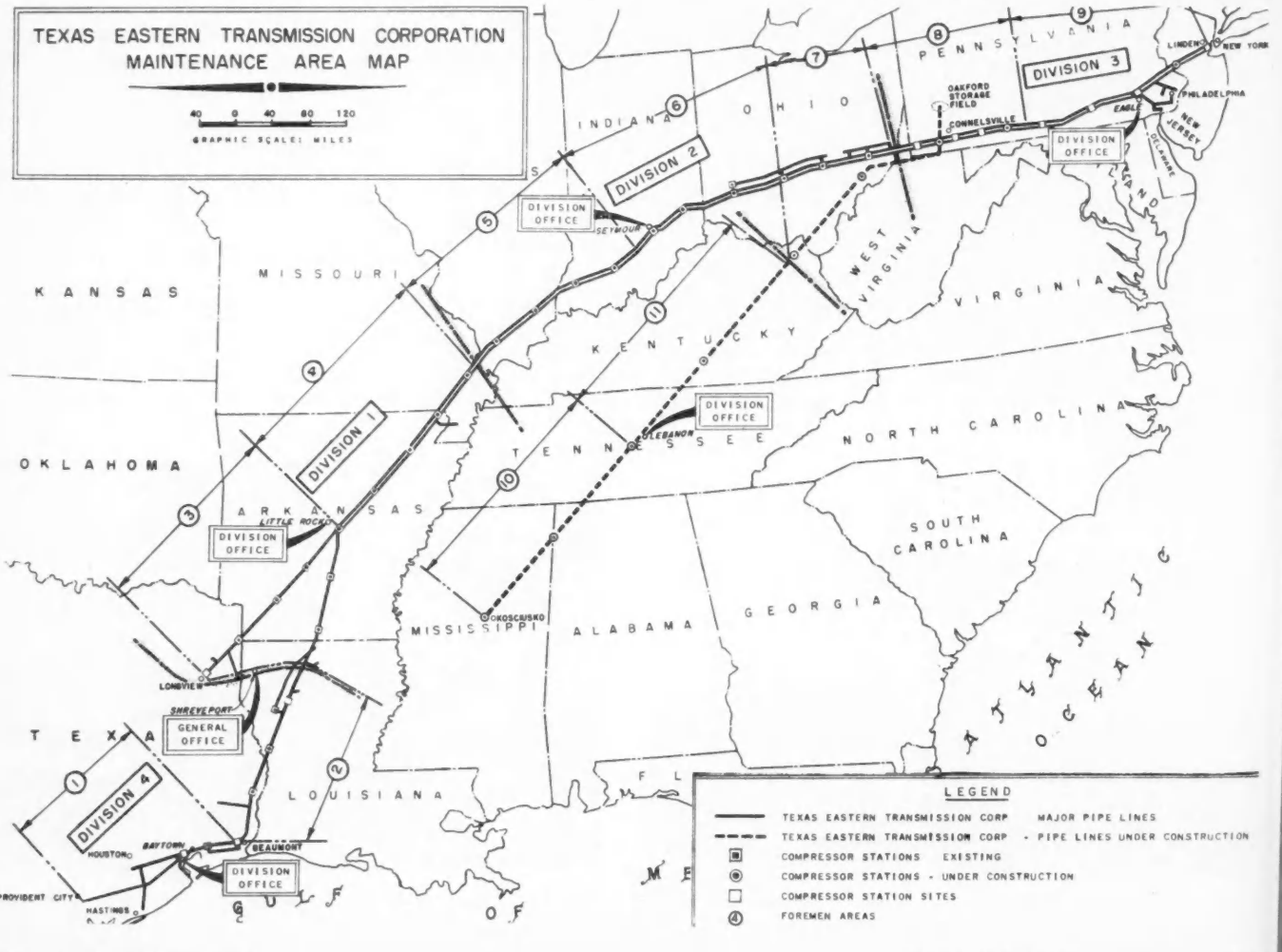
Texas Eastern's maintenance operation is designed so that in case of a major project or emergency, adequate equipment and competent personnel will be near enough to any location to make repairs and changes in the shortest possible time and yet be dispersed to maintain the system in the most economical manner.

About the Author

H. M. McDONALD was born in Weatherford, Texas, and left high school to begin his pipe line career at the age of 17 with The Texas Pipe Line Company.

Fifteen years of hard work on various pipe line jobs and many nights of diligent study brought their reward in 1933 when he became a division superintendent for Atlas Pipe Line Company. He subsequently held positions as division superintendent for several pipe line companies, including Pan American Pipe Line Company and War Emergency Pipelines, Inc. In May, 1947, when Texas Eastern began operating the former "Big and Little Big Inch" lines for the transmission of natural gas, McDonald remained as division superintendent. He was promoted to his present position as pipe line superintendent in May, 1948.

Division	Location on Map	Miles of Pipe	Miles of Right-of-Way	No. of Crews
1	(3)	425	419	4
1	(4)	476	243	2
2	(5)	408	204	2
2	(6)	441	192	2
2	(7)	511	282	3
3	(8)	361	231	2
3	(9)	574	334	3
4	(1)	261	219	2
4	(2)	244	211	3
5	(10)	297	297	2
5	(11)	274	274	2
Total..	...	4272	2906	27



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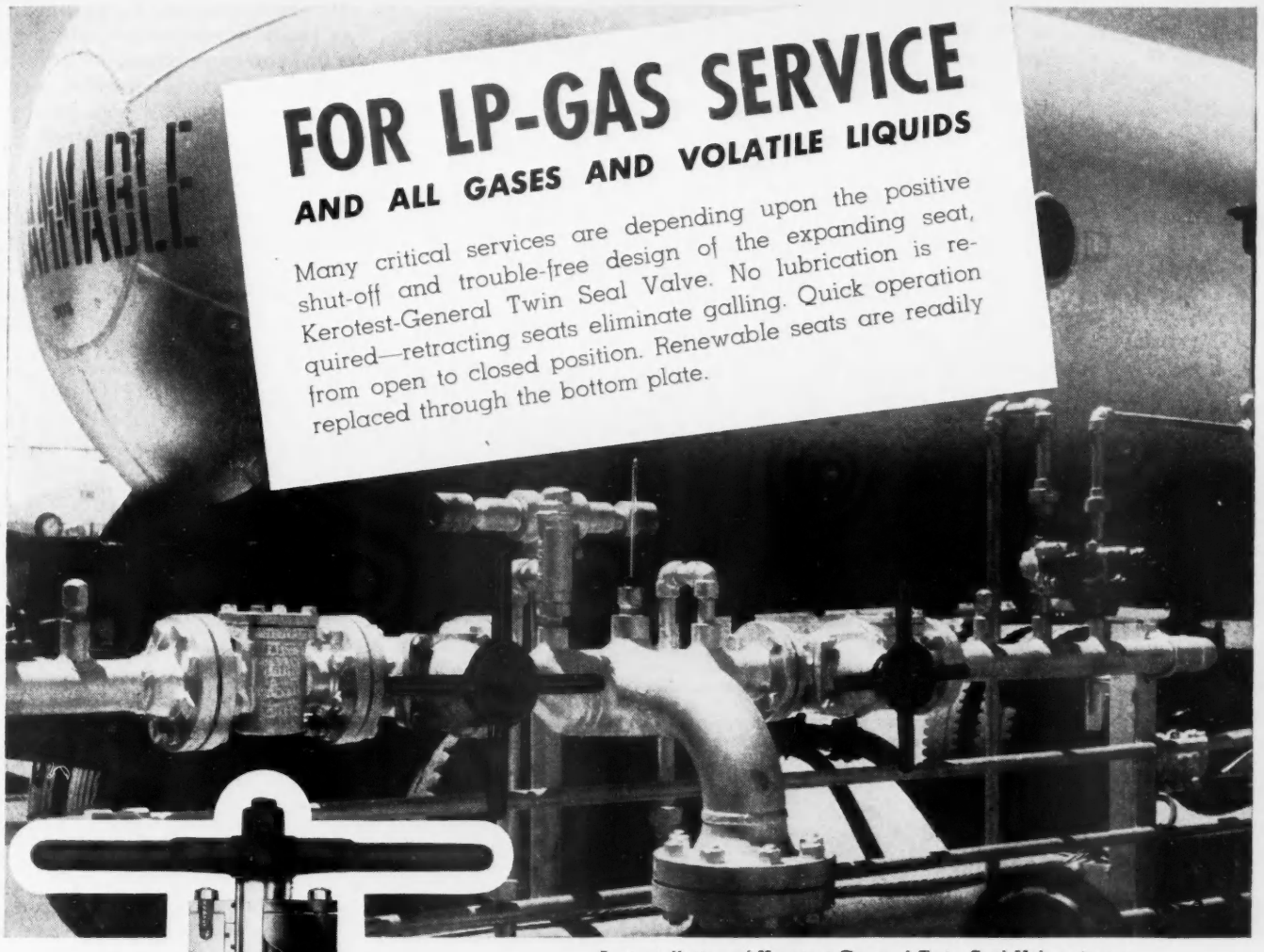
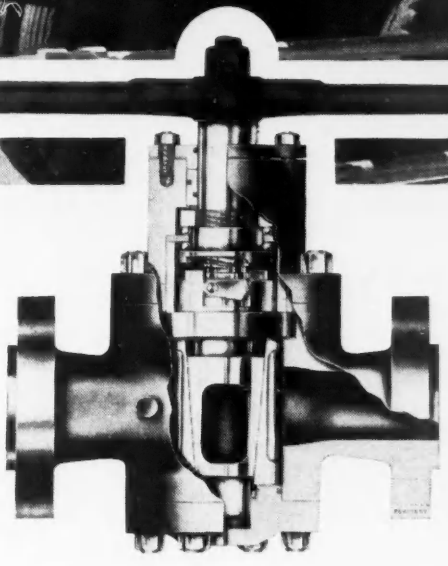


An installation of Kerotest-General Twin Seal Valves in an LP-Gas Loading Rack



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- ✓ No Lubrication
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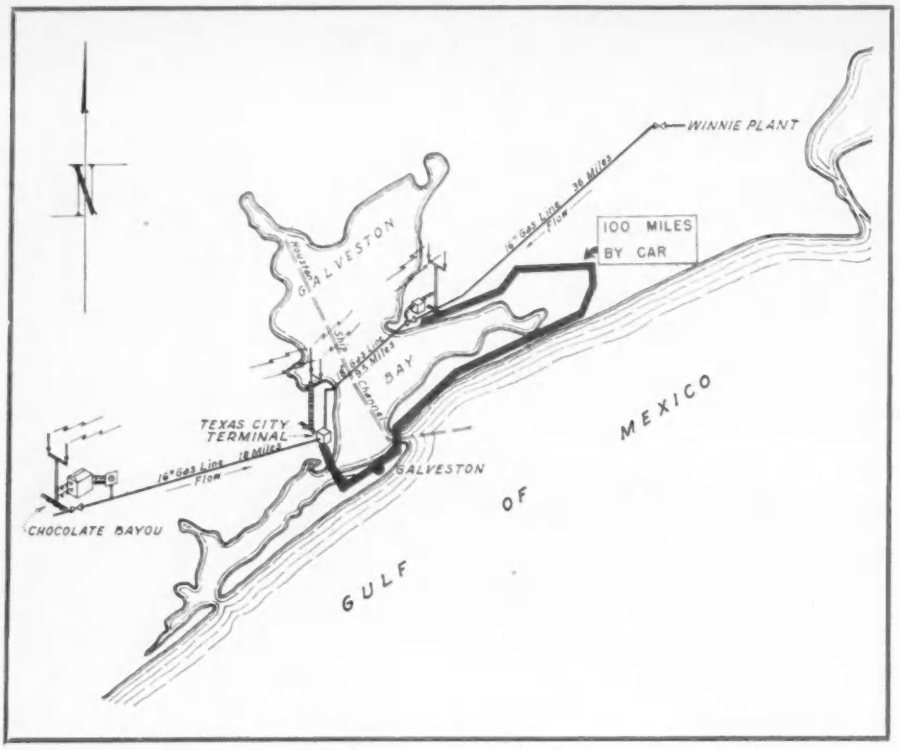


From the Texas City terminal, operators can push a button and operate a 16-inch valve at Smith Point 13 miles away. To operate the valve manually, employes would have to drive 100 miles and cross a ferry.

THE RELIABILITY of radio has long been acknowledged, yet gas company engineers have been hesitant to rely on it as a control medium for high pressure gas pipe lines. Pan American Gas Company will soon "go on the air" with the first system making full use of radio for operating a main line block valve and taking pressures at remote locations.

By J. O. PHILLIPS
Manager, Civil Engineering Department
Pan American Gas Company

FM Radio Controls Gas Transmission

A BUTTON is pushed in the control room of Pan American Gas Company's Texas City terminal. Thirteen miles across Galveston Bay—100 miles via land—a 16-inch high-pressure gate valve is closed. The only link between the terminal and valve is VHF (very high frequency) radio. The valve can be opened in the same manner.

A second button is pushed. The position of the valve—open or closed—is flashed back to the control room. Another VHF system telemeters pressures from Chocolate Bayou to the Texas City terminal.

This installation is a forward step in the progress of radio as a control and telemetering medium for high-pressure gas transmission. Designers have been reluctant to rely on radio for operating key system valves because of the terrific energy stored in gas pressure and because of the danger of fire.

The remote operations diagram shows the importance of the valve at Smith Point. A 16-inch line brings gas from Winnie to Smith Point, where it swages to 18-inch for the Galveston Bay Crossing.

The water-crossing passes beneath the Houston Ship Channel and its heavy marine traffic. A break in the line could result in serious damage to ships and marine installations. As with all pipe line breaks the first action should be to shut off the gas at the source. Failure to do this can increase loss and damage.

One-Minute Operation

Pan American will soon have an FM radio system in operation which will be able to close or open the 16-inch valve in about one minute. A series of audio impulses carried over the VHF acts on a number of relays at the valve to cause high pressure line gas to drive a pneumatic motor mounted on the elevated gear works of the valve.

A primary requirement of such a system is complete reliability, which is inherent in the design of the system, contingent only upon the power supply. To prevent failures from this source, standby generators are installed at each of the three locations which take over automatically in the event of a power failure, and automatically return the system to the power line when service is restored. The 12-volt storage batteries with capacities for a minimum of 40 hours of operation are maintained for this service.

The control for the Smith Point block gate is entirely a safety feature. Incorporated into the system are devices which indicate the position of the valve stem at any time to the dispatcher. The most important function of the system is the valve operation, equipped with the most positive safeguards.

It is absolutely essential that the

operating mechanism does not respond to spurious influences of any sort. The receiver at Smith Point is energized at all times, but the transmitter only when called by the dispatcher.

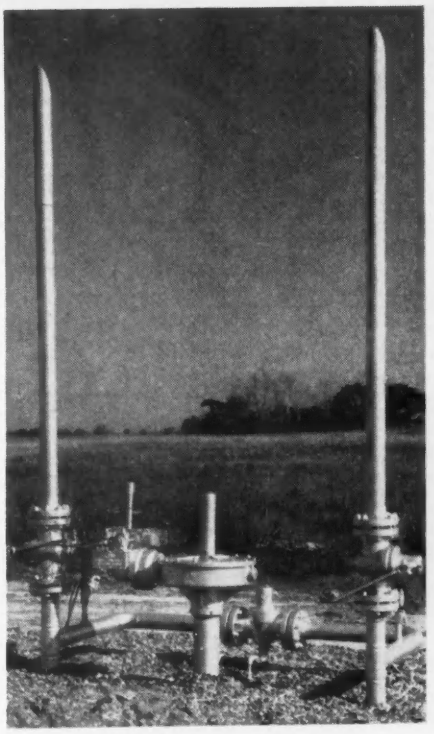
For example, when the dispatcher at Texas City wishes to know the position of the gate valve, he presses a button which sends a signal modulated by two low audio-frequency pulses. The receiver at Smith Point literally inquires of limit switches, the position of the valve; the transmitter in turn transmits a coded signal indicating that the valve is either open or closed. This information is conveyed to the dispatcher by pilot light.

The valve-operation signal then sent out from Texas City consists of three low audio-frequency pulses (in the range of from 100 to 300 cycles) in a definite sequence. These pulses are generated by fixed frequency units whose operating principle is that of a tuning fork energized by an oscillator circuit.

Receiver Reaction

At the receiver, three differently tuned reed vibrators, which respond to the same frequencies, activate by relay the operating mechanisms. This circuit which controls the valve-operating mechanism is energized only when the three proper tones are received, and in the correct order, within an interval not greater than six seconds. Thus, it is easy to see that the possibility of the same being activated by any spurious signal is exceedingly remote.

When the valve-operating mechanism has completed its operation in either direction, the same limit switch which indicates the stem position actuates a relay which causes the transmitter (it has already been energized by the reception of the operating signal) to flash the position of the valve. A pilot light shows the valve to be completely closed or open.



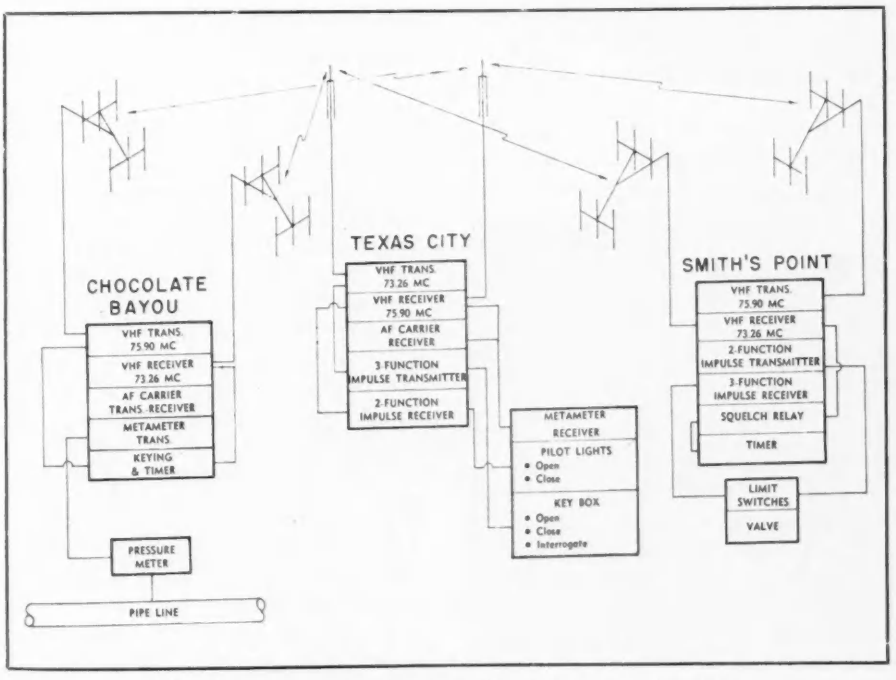
Radio-operated 16-inch high pressure gate valve at Smith Point.

At the Chocolate Bayou end of this system, the problem is one of telemetering pressure readings to the dispatcher at Texas City, an operation quite common in microwave systems. This is probably the first instance of telemetering via the VHF system. The dispatcher at Texas City pushes a button; this signal energizes the Chocolate Bayou transmitter and the transmitter sends an audio pulse, the length of which is in proportion to the pressure reading. At Texas City the receiver then actuates a moving pen and the height to which the pen climbs is controlled by the length or duration of the audio pulses and so indicates the pressure reading at Chocolate Bayou.

The same interrogation signal operates both the Smith Point and Chocolate Bayou transmitters. Information is received simultaneously from both stations, thus providing a frequent operating check of both outlying stations. The Smith Point valve-control function has an automatic overriding feature, permitting this emergency operation to be accomplished any time, interrupting the metering function if it happens to be in operation. The installation is not required to handle voice transmission except for testing purposes, since voice communication is already in operation on another frequency. The installation described is believed to be the first one of this nature utilizing the VHF-FM band.

Unusual Combination

A somewhat unusual combination of features made possible this application and possibly not all problems of this nature could be solved by a similar installation. The distances involved and the relative simplicity of the service in this case made it possible to effect considerable economy by the use of this band rather than the more expensive microwave band.



Schematic layout of Pan American Gas Company's radio system.

About the Author

J. O. PHILLIPS, manager, Civil Engineering Department, Pan American Gas Company, Houston, has been in pipe line work since 1943, when he joined Pan Am as an inventory engineer. Prior to 1943 he was a civil engineer with the Houston Lighting & Power Company, and was a surveyor for Shell Oil Company. In 1928 he left A. & M. College of Texas to do design work in Jamaica. He was made manager of the Civil Engineering department when Pan Am Gas was formed early in 1951.

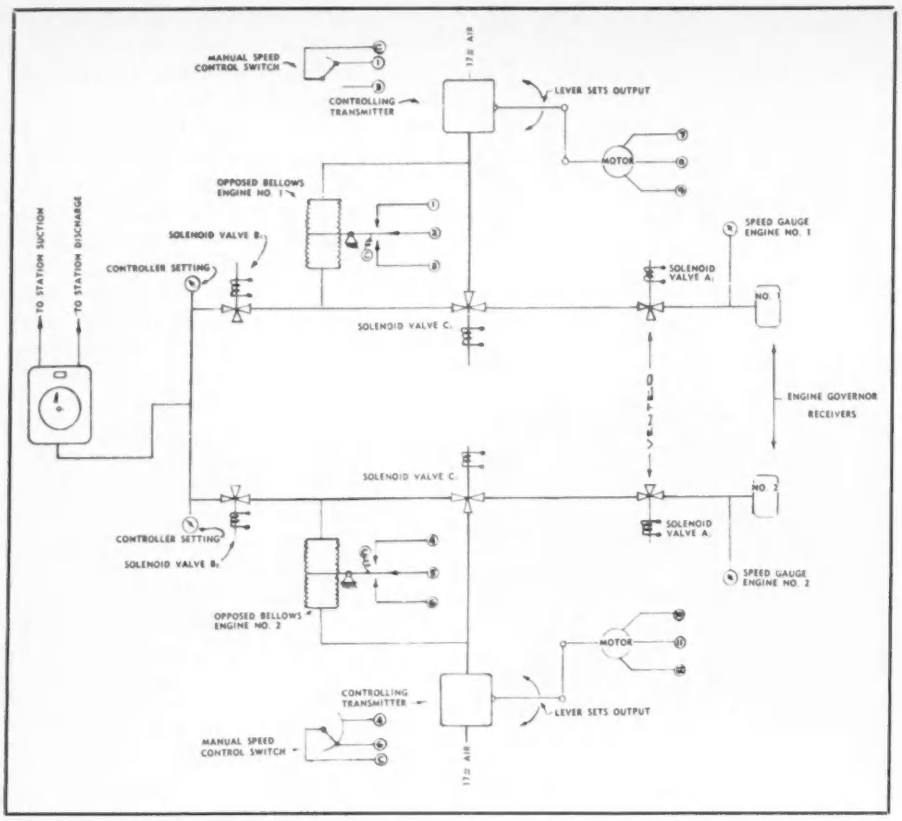


FIGURE 1. Pneumatic schematic governor control for two engines.

By C. B. LESTER

Chief Engineer
Mid-Valley Pipe Line Company
Longview, Texas

OUT OF the laboratories of manufacturers comes a constant stream of instrument improvements which mean greater operating efficiencies in pipe line pump stations. Here are some of the latest developments in instruments and their applications. This article is from a paper presented at the winter general meeting of the American Institute of Electrical Engineers in New York City.

New Control Hookups Save Pumping Costs

SCIENCE has made two more contributions to the pipe line industry.

- A governor control automatically starts multi-unit diesel stations and eases them on the line—effortlessly and smoothly.
- A load limit controller pays for itself every six months in savings by limiting the load during line-packing conditions and ordinary start-ups.

The governor control works like this: After the engine is rolled on air and is firing, it comes to a normal idle, if the engine is cold, it continues to idle until the "cold engine" conditions pre-set into the engine control system no longer exist. After the "cold engine" light disappears on the engine control panel, an "automanual" switch is turned to "automatic" after which the engine comes to its maximum pre-set operating speed, or to the maximum speed at which pre-set maximum discharge or minimum suction pressure conditions permit. The pull-in time can be set for any reasonable period of time, usually three minutes.

Second Engine

The second engine is rolled on air, and idles until warm. Then the "auto-manual" switch on this engine is turned to "automatic" and Engine 1 starts slowing down as Engine 2 starts picking up. This continues, holding line conditions constant, until both engines are operating at the same speed, at which time both engines go up in speed together until they reach some pre-set condition in engine speed, station suction or station discharge.

The third engine comes on in a similar manner, the first two engines slowing down until all three engines are operating at the same speed, after which all three engines go to their limits.

After all three engines are on stream normally, their speeds are kept the same and varied simultaneously to suit line conditions set up in the special type dual-pressure controller. Thus, if the engines are operating into a slack line, their speed is kept just as high as possible without tripping the low station suction pressure limit control. When operating into a packed line, their speed is

kept as high as possible without tripping the high station discharge pressure limit control. During all intermediate conditions, the engines operate up to the limit stops set into the engine governors.

The operation of the governor control used by Mid-Valley Pipe Line Company can best be explained by referring to the schematic diagram of the pneumatic circuits in Figure 1. Electrical connections are not shown for simplicity, but are described where pertinent to the operation.

Assume an engine is running on automatic speed control. The output of the dual-pressure controller is connected directly to the engine governor receiver, and the engine speed is under control of the dual pressure controller under all normal conditions. If a shutdown signal reaches solenoid valve A, the governor air is dumped and the engine goes to idle. If the abnormal parameter goes through the governor dump point very fast, an irrevocable shutdown is affected by tripping the engine fuel dump valve. This action is caused by having three on-off contacts on the basic group of instruments, the first contact sounding an alarm, continuing increase in deviation from the set point dumping air on the governor, and continuing increase causing the engine fuel dump valve to operate.

To start a second engine, it is rolled on air and brought to a pre-set idle until the "cold engine" conditions set into the engine control stand no longer exist. The second engine is then switched to automatic control.

Since the output from the dual-pressure controller now feeds two engines, it tries to drop because of the increased volume. Immediately the C solenoid valves tie the governors into the controlling transmitter in the governor control. Then, because an unbalance exists between the dual-pressure controller output, Engine 1 controller transmitter being too high, and Engine 2 controller transmitter being too low, the opposed bellows actuate electrical contacts which slowly move the set point of the controller transmitters by rotating the reversible motors until the opposed bellows are in balance. Then both engines come under the control of the dual-pressure controller as the C solenoids go back to their normal conditions. This system can be used for any number of engines.

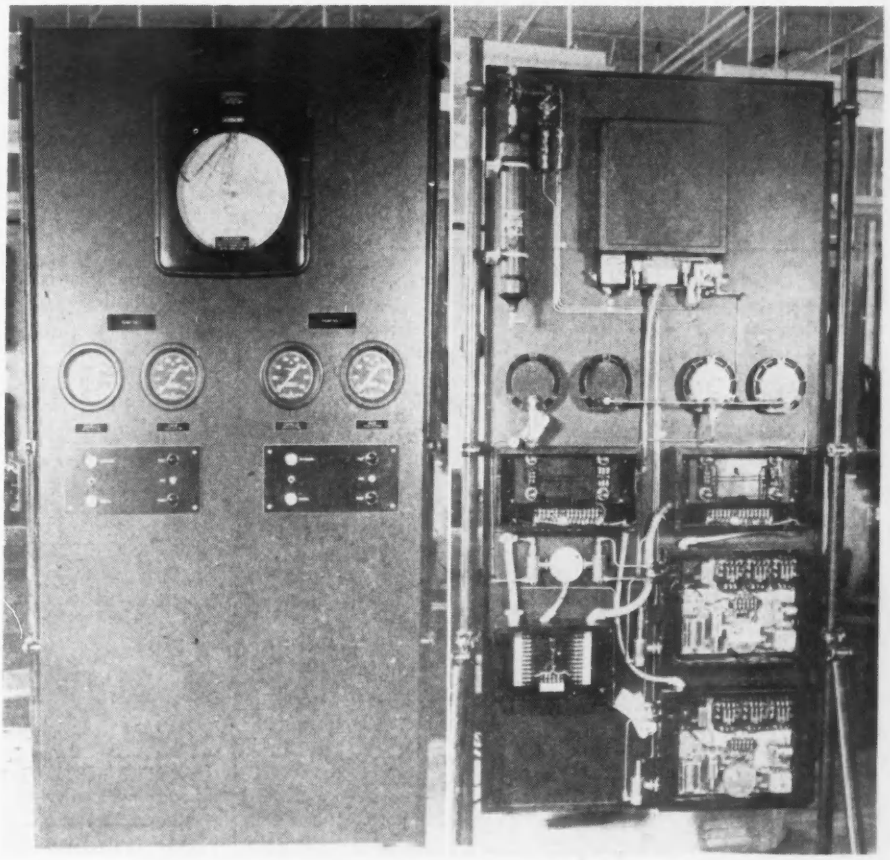
The "governor control" will set the speed of the engines in the critical speed range if the line requirements are such as to require such operation. To eliminate this very dangerous condition, the discontinuous function controller was devised.[2]

Discontinuous Function Controller

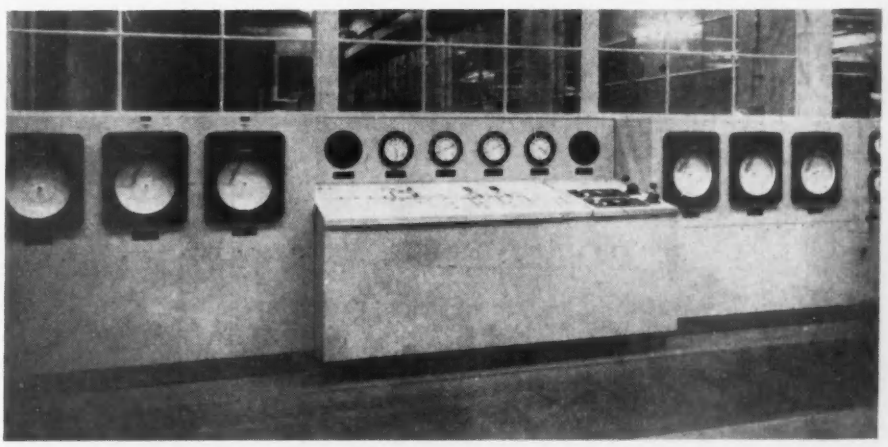
The output pressure from the dual-pressure controller is connected through a totalizing relay to the engine governors. When the engine speed as measured by the auxiliary controller is below or above the critical zone, the totalizing relay merely repeats the output pressure of the dual-pressure controller to the governor.

For a critical speed range of 250-275 revolutions per minute, the auxiliary controller is set so that its output pressure will be 1.6 pounds at 250 and 0 pound at 275.

On increasing load, engine speed increases to 250 revolutions per minute. At this point, a three-way value supplements the output of the auxiliary controller to the dual-pressure controller output through the totalizer adding 1.6 pounds to the governor air pressure, bringing the



Left, front view, and right, back view of engine speed control panel. Controller shown is dual-pressure controller. Two units shown in lower right rear are governor controls.



Central control position—engine station.

engine quickly to 275 revolutions per minute.

Simultaneously, the three-way valve in the line to the bypass valve connects the diaphram of that valve to the dual-pressure controller applying 9.6 pounds to it, opening it immediately to about 75 percent capacity. This 75 percent is approximately equal in bypassing capacity to a 250 to 275 revolutions per minute increase in engine speed. The dual-pressure controller then adjusts its output pressure so that the bypass valve exactly makes up for the changed engine speed insofar as the line is concerned.

Bypass Valve Closed

As the load increases, the output of the dual-pressure controller increases, thereby closing the bypass valve. Because of the totalizer, the engine speed is a function of the sum of the dual-pressure controller output pressure and the auxiliary controller output pressure, and since the former increases exactly as the latter decreases, the engine speed remains constant.

When the dual-pressure controller output pressure has reached 11.2 pounds, the control valve is closed, and the output pressure from the auxiliary controller is zero, and further increase in output pressure from the dual-pressure controller will cause an increase in engine speed.

On reductions in speed through the critical speed range, essentially the reverse of the above conditions takes place.

The relation between dual-pressure controller output pressure, engine speed, bypass valve position, and three-way valve trip points is shown on the alignment chart. The gap between the three-way valve trip point and release point is necessary to guard against jumping engine speed up and down when the system load is such that an engine speed of close to 250 revolutions per minute is required.

Load Limit Controller

In locations where it is desirable to limit station demand for any reason, especially during line-packing operations when excess demand charges are incurred for no useful purpose, the load limit controller will likely prove helpful.

It does two things:

- It saves the motor windings from overload currents.
- It holds down demand charges to a pre-set maximum, all the while permitting the station to get on stream as quickly as possible during start-up conditions without damaging itself.

As for costs, it has been calculated that this device will recover its cost after taxes in less than six months with a normal number of start-ups.

The operation of the load limit controller is to feed a third variable into the two-variable controller used to control the position of the throttle valve in the electric stations. Normally this controller holds a maximum discharge pressure or a minimum suction pressure, depending on which happens to be the limiting variable at the time. During start-up, however, operating into a slack line, these parameters read falsely insofar

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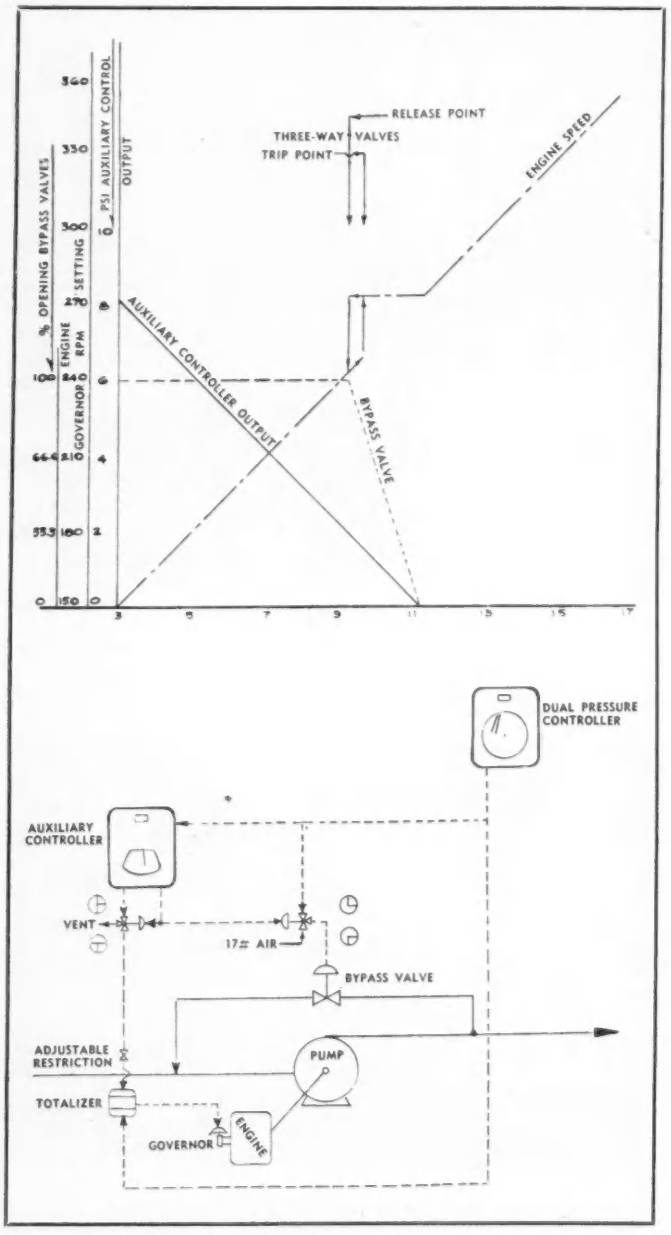


FIGURE 2. Discontinuous function controller.

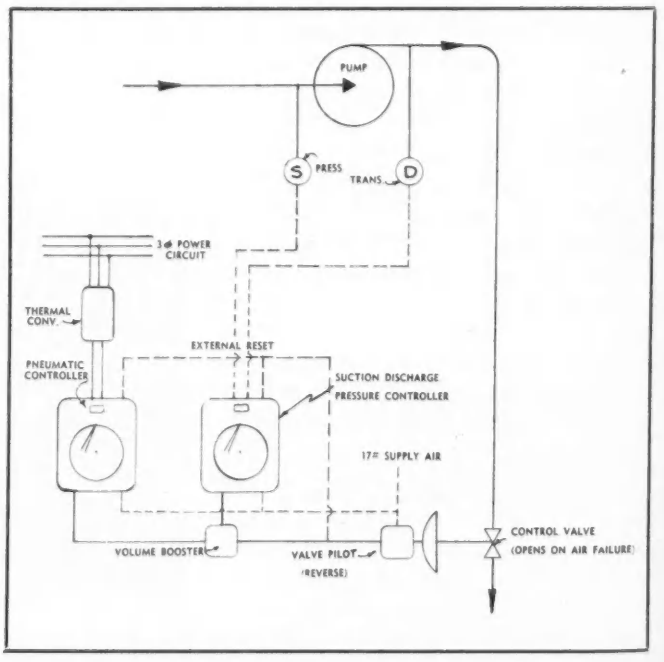
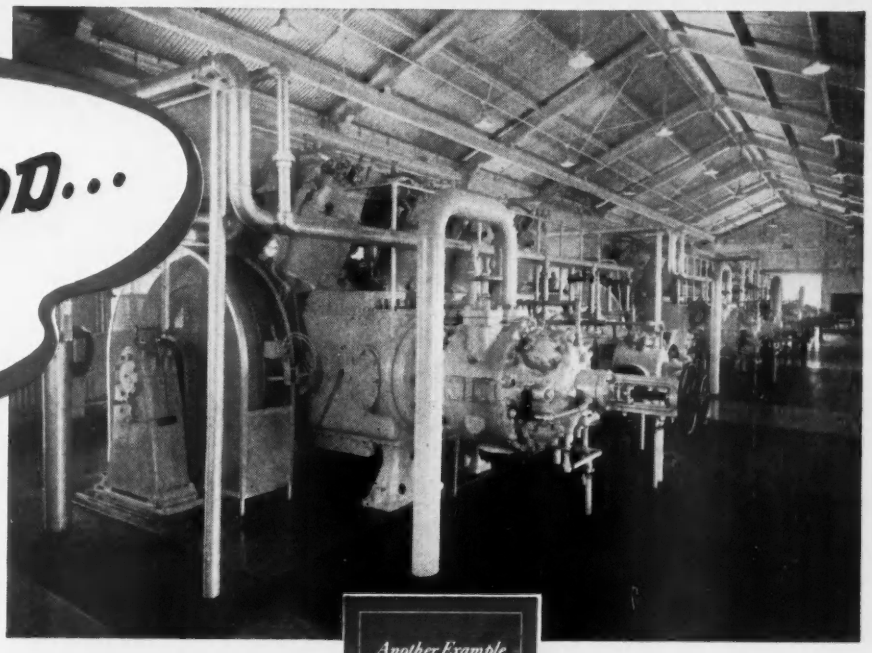


FIGURE 3. Load limit controller.

AT CHITWOOD...

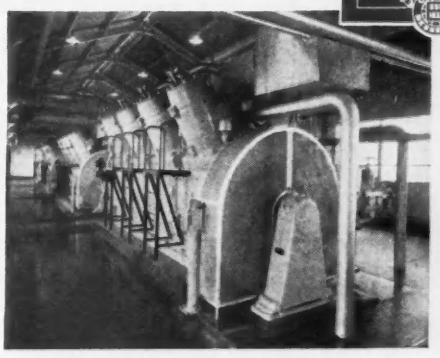
BROAD GAS CONSERVATION with multi-service GMV's



Line-up of four Cooper-Bessemer 8-cylinder GMV compressors, rated 880 hp at 300 rpm, in Magnolia Petroleum Company's Chitwood Gasoline Plant. Here, multi-service operation involves 4800 psi discharge in cycling, 1,015 psi in gasoline extraction, 250 psi for vapor recovery. Flexibility is a keynote.

Another Example of Efficient Power at Lower Cost

GMV's in Magnolia Chitwood plant, shown here from crankdoor side.



Exterior view of compressor building at Magnolia's Chitwood plant.

AT THE Chitwood plant, Magnolia Petroleum Company is doing an outstanding job of gas conservation . . . perhaps unique. The operation includes production of distillate by cycling . . . production of gasoline from casinghead gas . . . vapor recovery off of crude at atmospheric pressure . . . and a pressure maintenance operation.

The operation is of particular interest because it involves both high and low pressures, together with the vapor recovery service — all tied into the same compressor units.

As shown opposite and below, the compressors are efficient Cooper-Bessemer GMV Turboflows — chosen partly because they assure the true flexibility so essential in a multi-service operation such as this.

Whether your plans call for complex compressor service or the most simple kind of set-up, you'll be ahead with Cooper-Bessemer V-Angles. Then you'll be sure of economical installation, prolonged, low-cost performance, and the *flexibility* to meet fixed or variable requirements precisely. Better check with Cooper-Bessemer.

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FIGURE 1 (left). Left side view of truck. Long tools lie crosswise of truck in lower compartment. Employes' luggage, first aid kit, batteries and seldom-used equipment are stored on this side.

FIGURE 2 (below). Closeup of right side of truck showing compartments containing hand tools, instruments and other equipment. The operator, using the compartment door as a work table, is placing chart on recording voltmeter.

Truck Facilitates Corrosion Control

By F. C. WATERS
Southern California Gas Company

A LIGHT truck to carry almost any tool or instrument necessary for corrosion control work is being used by Southern California Gas Company.

Little can be accomplished in a corrosion study or investigation without suitable instruments and equipment. They are as essential as a knowledge of the fundamentals of corrosion.

The required accuracy and dependability of the equipment depends upon whether it is to be used for laboratory testing or for general field corrosion and cathodic protection measurements. In the case of field work reasonable engineering accuracy is desirable and, where it is necessary to transport the testing equipment, it is essential that the instruments arrive in good condition, that the proper equipment and tools are available on the job and that they are conveniently located so that the work can proceed with maximum speed and minimum effort.

This new truck will carry the necessary equipment and will not damage the instruments while in transit. This body is mounted on a truck chassis that is sturdy and powerful enough to go most places that a survey crew is required to go.

MODIFYING TRUCKS for special purposes is not new. But this is perhaps the first time a truck has been modified for the express purpose of making corrosion studies and carrying on corrosion work. This paper was presented at the Pacific Coast Gas Association Technical Services Conference, March 5 and 6, in Fresno, Calif.

Any standard make one-ton capacity truck chassis with four-speed transmission is satisfactory. The tires should be 17. x 7.50 - 8 ply. It has been found more desirable to drive over the pipe line right-of-way and work from the truck rather than carry heavy equipment on foot when the pipe line does not follow a public road or highway. Therefore, the four-speed transmission and large tires are necessary in desert and mountain terrain.

The truck body is 96 inches long by 72 inches wide, and when mounted on a 137-inch wheel base truck there is room to mount a spare tire and water canteen between the body and cab. The body is constructed of sheet steel which is riveted and spot welded. Figure 1 shows the left side of the truck with the compartment doors open. This is the type used for cathodic protection work, principally outside of metropolitan Los Angeles. The compartments on the left side are designed to carry the equipment used most infrequently such as batteries, tool box, first aid kit, employe's luggage, etc. These compartments are not lined with shock absorbing material. However, the lower rear compartment is lined with lead and has ample room for three storage batteries.

For safety purposes the instruments and the most frequently used equipment are located on the right side of the truck as shown in Figures 2 and 3. Whenever possible traffic is routed to the left of the truck. The instrument compartments are lined on four sides with rubber, and in the six years that this type truck has been used there has been no damage to instruments in transit. The photographs

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FIGURE 3. Operator shows how fish reel unit is installed in grooved receptacle on rear of body panel. The grooved mount is used also for holding a small vice.

FIGURE 4. Here the operator talks with an assistant over the field telephone. Reels and test equipment are set up for a typical job in the field.

on these pages show the arrangement for storage of the telephone set, pipe locator, potentiometer, soil meter and recording voltmeter. However, it is possible to carry other types of instruments in these compartments. The top front compartment has two sliding drawers for such items as battery clips, lugs and bolts. Immediately above the drawers are stored various sizes of resistance wires and lead wires. The lower front compartment extends the width of the body and is for long tools such as bars, shovels and sledges. The door of the top rear compartment is used for the work table during tests. When moving from one location to the other the instrument in use is usually carried in this compartment. Immediately below is the compartment for hand tools. While this compartment is a convenient place for tools, difficulty has been encountered from jarring of the tools onto the compartment floor when in rough terrain, and also from losing such tools as 4-inch wrenches from the compartment door. It has been necessary to shift the tools from the original arrangement and to design special clips for securing them to the boards. The arrangement shown in the close up photograph of the tool compartment appears to be satisfactory, and the number of lost tools has decreased since adoption of this arrangement.

The company also has equipped another truck that is used in street railway stray current investigations. It differs from the other in that the compartments on the right side carry eight recording voltmeters, and the indicating instruments have been moved to the left side thus eliminating the luggage compartment.

A platform mounted above the body has been added for use in stringing test wires in elevated positions on poles or trees for 24-hour pipeline potential gradient measurements. The platform can be removed when it is not in use. The platform is equipped with a protective railing. A ladder

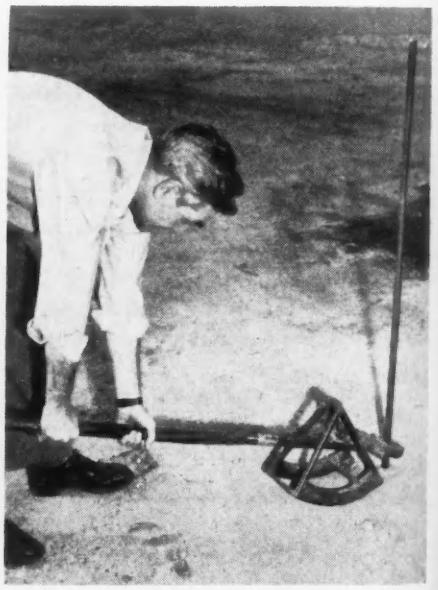

FIGURE 5 (left). A safety measure which also facilitates frequent climbing into the truck is the retractable step built into rear body panel.

FIGURE 6 (right). This ingenious shop-made rod puller is included in equipment carried on the truck. It is built with readily available pipe material with leverage provided by a removable pipe handle.

For Economical Gas Lift

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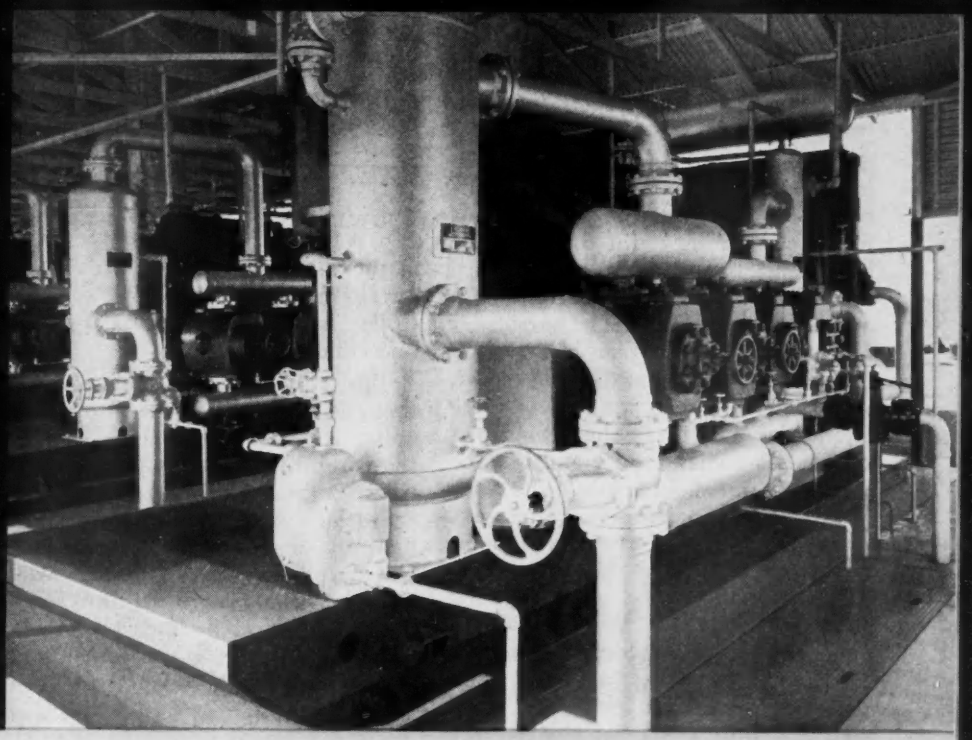
PACKAGED COMPRESSOR PLANT



A bank of four Beaird-Ingersoll-Rand packaged compressor plants in gas lift service in South Texas.

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YOU CAN BE SURE of the most efficient production from every well in your gas lift system . . . when you use a Beaird-Ingersoll-Rand packaged compressor plant. No matter how variable the demand for gas from individual wells, each well will always receive the volume of gas it needs at the required pressure. Yet there is no need for popping off or flaring gas, because the compressor automatically adjusts itself to demand. Its 4-cycle engine, with automatic speed and pressure regulators, slows down to 50% or speeds up to 100% to keep the gas supply uniform at all times.

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L.P.G. SYSTEMS

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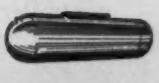
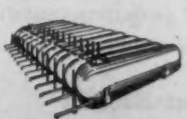


ANHYDROUS AMMONIA EQUIPMENT



PRESSURE BULK STORAGE

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also is carried for use where the platform is not practical.

A rear view of one truck is shown in Figure 4 with the compartments open. The white stripes are luminous for safety during night driving. The left compartment carries the distance measuring wheel, traffic barricades and vault cover lifters. The barricades are arranged so they can be removed from the trucks rapidly. The speed with which one man can remove these barricades and place them to direct traffic has contributed greatly to the safety of our field crews. The wire used for potential gradient measurements is carried in the center compartment. Insulated No. 18 gauge stranded wire is used on three 2500 foot reels and one 1500 foot reel in each cathodic protection truck. The fish reels shown at the right and which are mounted on a steel panel that fits into a special slot on the rear of the body are used to make connections between the instruments and the copper-copper sulfate electrode and the pipeline. There are approximately 150 feet of No. 22 gauge neoprene insulated wire on each reel.

Reeling out wire from the large reels is accomplished by securing the reel to the truck bed by means of a clamp and thumb screw. A method has been developed whereby this operation can be carried out in city streets without particular hazard.

Figure 5 shows a retractable step built into the rear body panel. This facilitates frequent climbing into the truck. And included in the equipment carried by the truck is an ingenious shop-made rod puller (Figure 6). It is built from readily-available pipe material—a ¾-inch steel round bar and a piece of 1-inch plate for the jaw grip. The unit, with leverage provided by a removable pipe handle, will easily pull the most solidly sledged bar.

The principal advantages in using this type truck are:

- All equipment necessary for a survey can be carried. There is ample room to carry an assortment of small items such as nuts and bolts that are not used every day, but often necessary.
- The truck handles well in traffic and will go most required places.
- The compartments provide maximum protection for sensitive instruments, are conveniently arranged and when the truck is used properly provides maximum safety for personnel.

New Control Hookups

■ CONTINUED FROM PAGE 262

as the valve is concerned because the setting of their limits into the controller is based on normal, packed, line conditions.

The method of attack was first thought to be in the realm of developing a signal proportional to flow that would keep station flow to something normal during line packing operations to hold demand and motor load to something near normal. It was found, however, that this would involve comparing the differential pressure put up by the station with station flow in such a manner as to reflect the relative amount of power being used, so it was decided to develop a signal proportional to station power directly.

Briefly, the device operates as follows: Three variables are fed into the devices controlling the throttle valve. Since, during line packing conditions, discharge pressure limitations are not met, this variable is not considered. Usually, disregarding station load, the throttle valve opens until the station suction is pulled down to its low limit and opens slowly as the station flow drops and discharge pressure rises while the line is being packed, finally coming off suction control and controlling on discharge pressure.

During the interim period, if the throttle valve setting, determined by the two-variable controller, is not preset considerably less than the limits used on a normally operating line, the demand and flow reach abnormally high values. It is not unusual to load a motor (or motors) to thirty or forty percent overload during these conditions.

With the proper equipment, the following solution can be executed. A signal is developed with a thermal converter proportional to power taken by the station. A pneumatic controller reads this signal, and converts it into a pneumatic signal in the usual 3-15 psi range. This signal is compared in a relay with the limiting signal coming from the suction-discharge pressure controller, and the limiting signal from the comparator relay is fed into the throttle valve operator. Thus, if the demand of a station at full load is (say) 3000 Kilowatts, the system can be set to allow the pneumatic signal developed in the thermal converter-pneumatic controller circuit to override all other signals and hold station demand to the pre-set limit.

Principles of load limit controller operation are illustrated in Figure 3. If either the suction or discharge pressure control units causes that controller to have a lower air output than the pneumatic controller connected to the thermal converter that the volume booster is acting as a 1:1 relay using the output air from the pneumatic controller connected to the converter as supply air and the air pressure to the valve will be precisely that of the limiting signal from the dual-pressure controller sensing station suction and discharge.

Conversely, if the lower output pressure comes from the thermal converter's controller, the volume booster is merely held open by the higher output from the dual-pressure controller and the thermal converter controller output goes directly to the control valve. The external reset connections are necessary because the reset air pressure of a controller is the same as the valve motor pressure.

Under normal operating conditions, the power requirements will not exceed the set point of the thermal converter controller and the station will be controlled on station suction and discharge pressure.

Power for Start-Up

Under start-up conditions, operating into a slack line, the power requirements can exceed those limited by either station suction or discharge pressure. With the load limit controller, the signal from the thermal converter controller takes over and holds the demand to the pre-set maximum, gradually letting the discharge pressure come up under constant power input conditions until the power required is less than the setting of the thermal converter controller, after which time the thermal converter controller is inactive during all normal operations.

It should be mentioned that a similar system can be easily set up for diesel units to prevent overloading engines while bringing them on stream in the minimum time during starting-up operations by feeding a limiting signal developed from the flowmeter into the system exactly as is the power signal in the unit described.

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If you didn't know all these facts about McEvoy Valves, ask a McEvoy representative to call on you and give you the complete story. Better yet, make your next valve order an order for *McEvoy* Valves.

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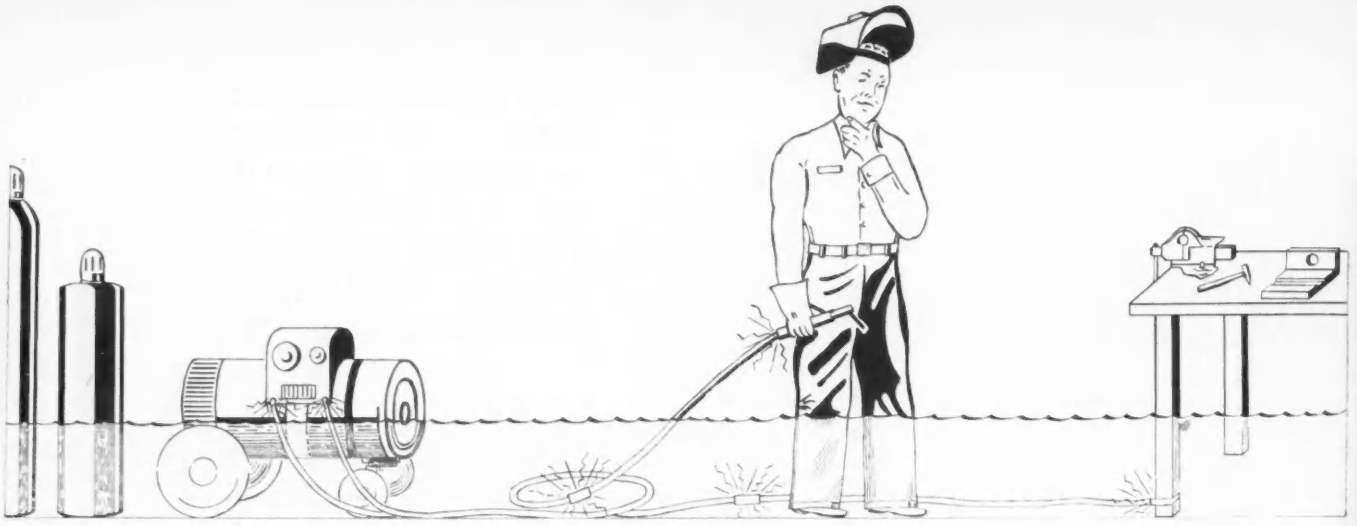

Eliminate Welding Current Leaks

By R. L. TOWNSEND

General Manager, Tweco Products, Wichita, Kansas

ELIMINATING welding current leaks can speed pipe line welding by freeing welders from needless machine adjustments and from burned hands. This can be accomplished by following a few basic rules in sizing electrode holders and welding leads and in proper electrical maintenance.

Welding cables may be likened to "pipe lines" carrying current from a welding machine which acts as a "pumping station." Amperage can be compared to volume of current and voltage to pressure. As with pipe lines, leaks mean trouble. One bad connection on either ground or electrode cable can make the whole circuit hot-running and inefficient. The current variation can cause bad welds.

When a welding machine runs hot or turns cold, it usually indicates an inefficiency somewhere in the cable circuit, although loose connections in the machine or overload can cause winding, insulation, armature or stud burnout. Smart operators check cables and connections before assuming the machine is out of order.

Hot electrode holders, hot ground clamps, connectors, lugs or splicers ordinarily are a result of loose connections, but can be caused by broken cable strands which cannot be visually detected. Use of undersize equipment, corrosion, and wear can also be contributing factors.

VITAL FACTOR in the arc welding process is a variable, high-amperage, low-voltage electrical circuit. High efficiency in the circuit can be obtained by following a few basic rules in selecting and maintaining equipment. The reward can be faster and better welds.

Inefficiency in the cable circuit, hot electrode holders, heating grounds are indications of electrical trouble. Below are listed check lists which will help in determining and correcting these troubles.

Inefficient Cable Circuits

1. Make a quick visual inspection of the entire welding circuit for cable breaks or "shorts."

2. Check lugs or terminals bolted to machine studs for tightness and possible corrosion of contact points. (These are often concealed under covers or on backs of control panels where difficult inspection makes for infrequent checking.)

3. Check wing nuts. (Wherever possible, eliminate wing nuts. It takes a wrench to tighten a square or hex nut, but tightness is assured. Finger-tightened wing nuts loosen easily from cable tugging by the welder.)

4. Determine that both electrode and ground cable are of sufficient size for the amperage use. (Table 1.)

5. For highest efficiency never cut out cable strands in order to attach cable to equipment too small to accommodate the full cable.

TABLE 1

Cable Size No.	Amperage Capacity of 50-Ft. Cable Length	Diameter Over Bare Conductor
6	75	.210 inch
4	100	.275 inch
3	150	.305 inch
2	200	.335 inch
1	250	.400 inch
1/0	300	.440 inch
2/0	375	.490 inch
3/0	450	.545 inch
4/0	550	.635 inch

(Increase cable by one size for each additional 50-ft. length.

Hot Electrode Holder

1. Check for loose mechanical connection or attachment of cable to holder. All mechanical connections should be further tightened after the holder has been in use for a short time.

2. Never use lead or "spliced-on" holder or whip cables too small for required amperage. Do not use longer cables than necessary.

3. Check for insufficient jaw pressure due to holder design; a loose spring does not correctly clamp the jaws.

4. Look for dirty or corroded jaw contacts. An occasional light touch-

READ:
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THIS ISSUE
PAGE 258.

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up with a three-cornered file eliminates this trouble.

5. Do not use a holder too small for amperage.

6. Look for holders which have worn or burned insulation, permitting greater "soakup" of reflected heat from hot jobs. Some insulations actually hold absorbed heat in the holder. A small guard installed on holders where the work is exceptionally hot eliminates that troublesome "welders forefinger burn" and greatly reduces the absorbed heat in the holder handle.

7. Check for inefficient current transfer to upper jaw of tong-type holders due to shunt or pin corrosion or breakdown.

Heating Ground

1. Look for loose or broken cable attachment; dirty contacts on the clamp, ground or work.

2. Do not place ground at a point distant to the arc; forcing current to travel through a moving contact is done at a great loss and sacrifice of a stable arc.

3. See that spring or pressure clamps are not placed on thin sections which do not provide maximum jaw pressure needed for high current work. Place the clamp on a thick section as near the arc as possible.

4. Remember that steel grounds lightly tack-welded for easy removal cannot carry high amperage equal to a heavy copper cable conductor.

5. Provide clean contact surfaces. Ground clamps of the spring- or screw-type installed on rusty, greasy or corroded surfaces dam up much current.

6. Remember that spring or jaw type ground clamps with cable attached to one jaw but not shunted to the other jaw can heat when the unshunted jaw is forced to carry current.

Welding, regardless of where it is done, can be no better than the cables and their connections that transmit the current to the point of deposition. When welders are cooling their hands or making needless machine adjustments, they cannot make a maximum number of welds.

The following are some general rules to assure circuit efficiency:

AMPERAGE OR VOLTAGE DROP: Proper allowance should be made on long cable hookups. A good rule of thumb is to increase the cable by one size for each 50-foot extension from a normal 50-foot length start. This is true of both A.C. and D.C. current, although the drop is greater on D.C. A long undersize cable will cause heating of the entire circuit. Avoid coiling of excess cable where loss from an unintentional magnetic field costs current, produces heat and oftentimes bad arc characteristics.

RESETTING CABLES: It is good practice to cut off 12 inches of cable when resetting any connection on holder, ground, lug or connector. Constant flexing near these stiff joints causes many fine wires in the stranding to break. The 12-inch setback is ordinarily a sufficient distance.

SOLDER ATTACHMENT: A good solder connection can be relied on to carry current more efficiently than the average mechanical connection. Where high amperages are used, silver solder is recommended. Brazed or copper welded joints are very efficient.

MECHANICAL ATTACHMENT: This method of attaching cables is advantageous for field operations and where heating equipment for installation is not available. Mechanical or clamp connections provide safety on certain jobs in that they will continue to operate even though they may run hot. Ordinary solders in such a case would melt and make a complete circuit failure. Mechanical connections retightened after one expansion and contraction from heat through usage are very satisfactory.

HEAT ABSORPTION: Short stubs can mean hot holders. Burning electrodes too short causes abnormal heat absorption in the holder. The expendable stub should be at least 1½ inches with two-inch length preferable. The shorter an electrode is burned, the hotter a holder will run. This is truly an inefficiency which causes premature insulation breakdown and holder burnout. It is "penny-wise and pound foolish" to burn down to one-inch stubs. A few pounds of rods may be saved each day but holders and insulation suffer the consequences—to say nothing of the operator's blistered hands and lost time.

Although an obvious fact, some welders forget that welding current does have volume and pressure represented by amperage and voltage. Unlike running water, oil, hissing steam or odorous acetylene, welding current being wasted through a loose connection makes no sound, no oily mess, no smell. Heat is the only danger signal and when the welding machine, cable or cable connections in the circuit "run a temperature" it is time to diagnose the trouble. "Kicking up the heat" at the machine to force the current through faulty connections may do the job at the business end of the electrode, but the operator pays a high price through loss of wasted power.

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PIPE LINE *Construction*

Projects Announced and Contracts Awarded

Crude Lines

Cities Service Pipe Line Company announced two important construction projects for 1952. The largest will be an 18-inch oil pipe line to be built from Sour Lake, Texas, to the company's Lake Charles, La., refinery. The carrier will be approximately 65 miles in length with a daily capacity of 150,000 barrels and will parallel an existing 12-inch line. The other project will complete the looping of the company's Cimarron Station to Cushing line. About 20 miles of 8-inch line will be laid and work was scheduled to start by the middle of March. The larger project will be constructed with pipe scheduled for third quarter delivery.

Creole Petroleum Corporation plans to construct 145 miles of 26-inch pipe line from Ule on Lake Maracaibo, Venezuela, to Amuay Bay. The line will parallel the existing 24- & 26-inch line laid in 1949 and will be started this summer. With one pump station the line will have a daily capacity of 100,000 barrels.

Hunt Oil Company plans to build a new 9-mile 4-inch line from the North Shongaloo field, Webster Parish, La., to Interstate Pipe Line Company's line at Haynesville.

Rancho Pipe Line System will be composed of 455 miles of 24-inch line from McCamey, Crane County, W. Tex., to the Houston area. Contracts have been awarded to Anderson Brothers Corporation, Houston, for the first 267 miles to Cedar Valley near Austin, and to Houston Contracting Company, Houston, for the last 188 miles to the Gulf Coast. The last section will include crossings of the Colorado and Brazos Rivers. Both sections are scheduled to be started in April.

Natural Gas Lines

Arkansas-Missouri Power Company has applied to FPC for permission to lay 140 miles of pipe line. The project will be built in two sections; one from Texas Eastern's line west of St. Francis River, Clay County, Ark., to Rector, Ark.; and the other from Texas Eastern's system near Campbell, Mo., to Evadale, Ark.

Cities Service Gas Company made application to FPC for permit to lay 16.8 miles of 6-inch line in Lafayette County, Mo. The new line would replace an existing 4-inch line.

El Paso Natural Gas Company has asked FPC for authority to build 2.2 miles of 6-inch and 4.7 miles of 4-inch pipe line from the Cogdell field, Kent County, W. Tex., to El Paso's 12-inch line in Scurry County.

Home Gas Company has petitioned FPC for authorization of 32.5 miles of line to be built in Chemung and Broome counties, N. Y.

Lone Star Gas Company has asked for FPC authority to carry out a construction program including 69.5 miles of 20-inch transmission line, gathering lines and three dehydration plants at a total overall estimated cost of $4,010,200.

Manufacturers Light and Heat Company has asked FPC for authorization to construct about 40 miles of new pipe line in Allegheny, Washington, and Beaver counties, Penn., and Belmont, Jefferson, and Columbiana counties, Ohio. The company also plans to retire approximately 34 miles of line in Allegheny, Washington and Clarion counties, Penn., and the two Ohio counties. In addition, a compressor station in Lawrence County, Penn., and another unit in Columbiana County would be retired.

Mene Grande Oil Company is planning to start construction on 30 miles of 26-inch pipe line between Puerto La Cruz, Venezuela, and a point to the southeast. Chicago Bridge & Iron Company, Ltd., Caracas, has the contract and will start about the middle of April, and is expected to complete by the end of May.

Natural Gas Company of West Virginia has asked FPC for permission to build 21 miles of pipe line in Columbiana and Stark counties, Ohio.

New York State Natural Gas Corporation has received FPC authorization to construct 104.7 miles of 14-, 16- & 20-inch loops in Westmoreland, Armstrong, Tioga, and Potter counties, Penn., and Wyoming, Onondaga, and Cayuga counties, N. Y. Also permission to add 1820-hp in existing stations in Westmoreland and Tioga counties of Penn.

The Ohio Fuel Gas Company has been authorized by FPC to construct 31.2 miles of 20-inch loops between Treat station, Licking County, Ohio, and Weaver storage field, Richland County.

Pennsylvania Gas Company has asked FPC for permission to add one 330-hp compressor unit in the Roystone station in Warren County, Penn.

Southeastern Kansas Gas Company, Inc. applied to FPC for permit to build 30 miles of 4- & 5-inch line from Cities Service Gas' line in Bourbon County, Kans., to Blue Mound, Linn County. Included in the application were 4.5 miles of 3-inch line to Moran, Kans.

Southern Natural Gas Company has asked FPC to authorize the construction of a total of 1254 miles of pipe line and installation of 22,250-hp in compressor stations on its system which extends from Tex. through La., Miss., Ala. and into Ga.

United Gas Pipe Line Company has been authorized by FPC to construct 11.3 miles of 20-inch line from Kent Bayou and Turtle Bayou gas fields, Terrebonne Parish, La., to the company's 24-inch line under construction in Terrebonne Parish.

Projects Starting

Crude Line

Stanolind Oil and Gas Company has started work on a 15-mile 3- thru 24-inch gathering system in the 3-Bar field, Andrews County, W. Texas. Vaughn and Taylor Construction Company, Wichita Falls, has the contract.

Product Line

Shell Oil Company has Parkhill Truck Company, Tulsa, unloading 280 miles of 14-inch pipe to be used on the new line from Wood River, Ill., to Chicago. This line when laid will replace the present 8-inch carrier. U. S. Air Force has started construction of 24 miles of 20-inch product line from the port of Casablanca, French Morocco to serve its air bases with motor fuel.

Natural Gas Lines

American Republics Corporation has started construction of 30 miles of 6-inch gas line in the Silsbee-Kountze area of East Texas. James S. Stewart Contracting Company, Houston, is doing the job. Archie Lacy Pipe Stringing Contractor, Houston, is stringing the pipe on this project.

United Gas Pipe Line Company has started 39 miles of 16-inch loop line from Bay Minette, Baldwin County, Ala., to Pensacola, Fla. L. E. Farley, Inc., Houston is doing the work.

Projects Completed

Crude Line

Service Pipe Line Company has completed 18.4 miles of 16-inch line from Raytown, Jackson County, Mo., to Sugar Creek, Mo. Sheehan Pipe Line Construction Company, Tulsa, handled the job for Service.

Product Lines

Gulf Oil Corporation completed 58 miles of 8-inch product line from a point near Beaumont to Deer Park, on the Houston Ship Channel, Texas Coast. Glaser Construction Company, Lafayette, La., was the contractor on the job.

Phillips Petroleum Company completed 28 miles of 12-inch line from Old Ocean, Brazoria County, Texas Gulf Coast, to Freeport, Texas. The job was handled by W. L. Golightly, Inc., Houston.

Natural Gas Lines

Interstate Natural Gas Company completed 20 miles of 4-, 6-, & 8-inch pipe line between Natchez, Miss., to Fayette, Miss. Actual construction was done by L. E. Farley, Inc.

Magnolia Petroleum Company expected to complete by the end of March 82 miles of 3-thru 24-inch gathering system in the Pegasus field, Midland and Upton counties, W. Texas. This system was installed by the Bishop & Lock Construction Company of Dallas.

Northern Natural Gas Company has completed a gathering system in the Hugoton gas field, Kansas, comprising 181 miles of 4- thru 12-inch pipe. Contractor on the job was Reese Brothers Construction Company, Hugoton, Kans.

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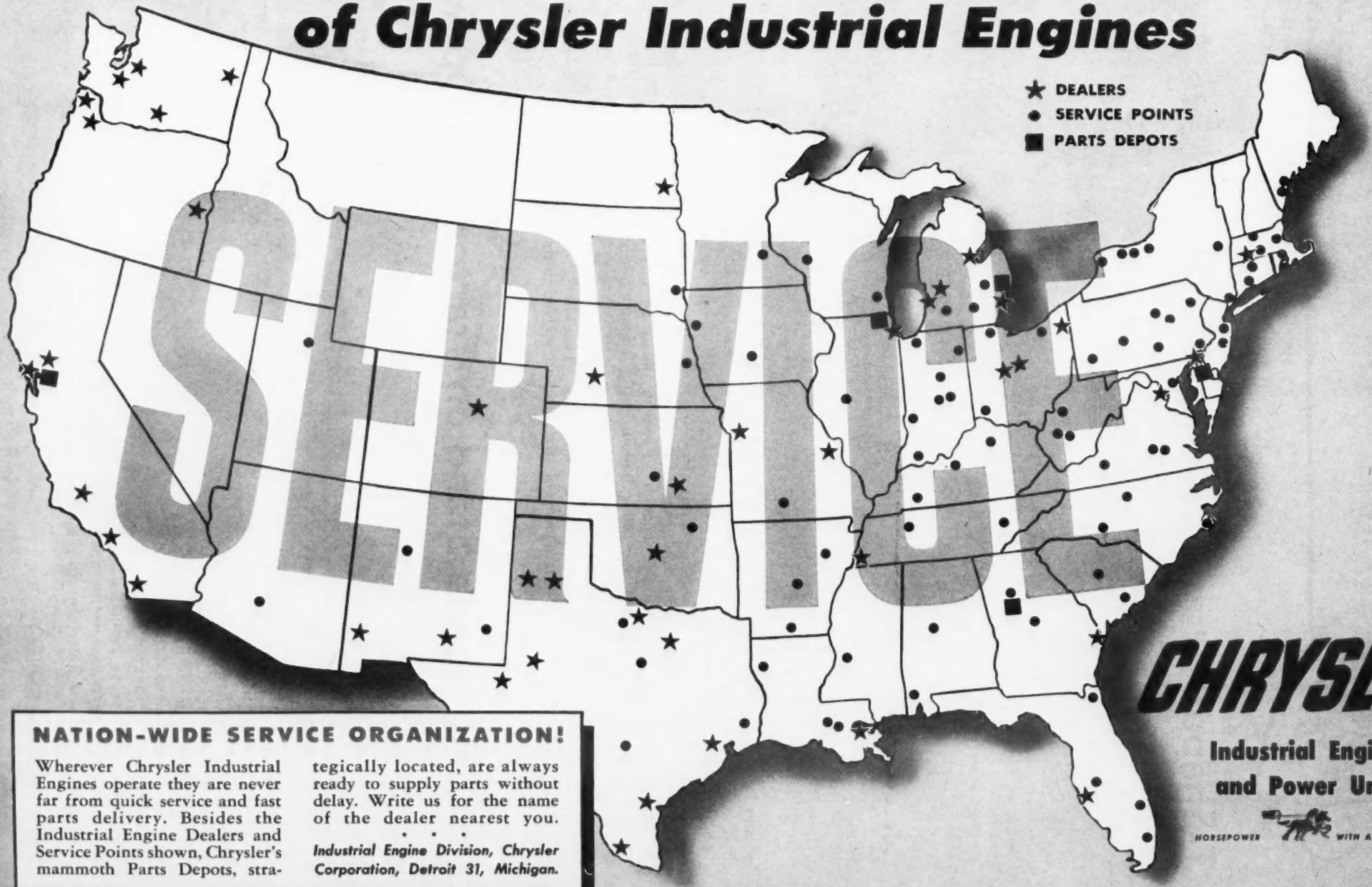

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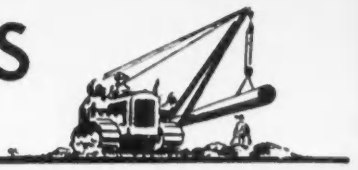
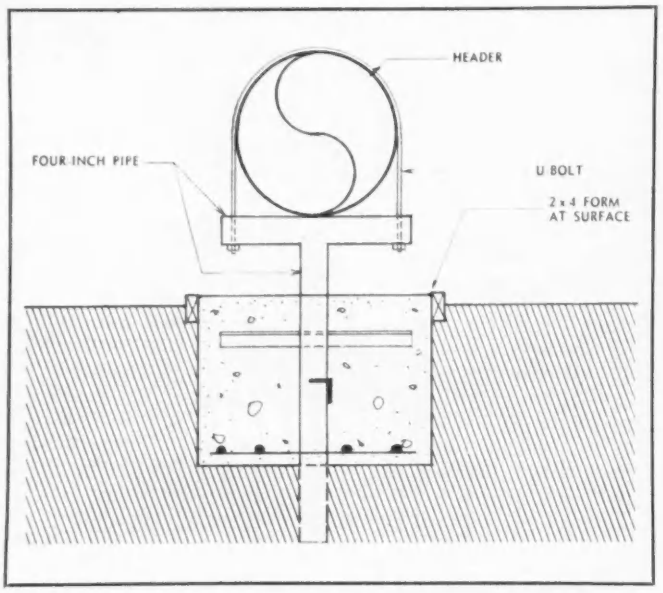


$10 is paid for each illustrated acceptable contribution. Mail to The Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas

T-Shaped Stanchion Pipe Supports Save Money

Pipe piers for headers can be replaced by a support made by driving a short pipe stanchion into the ground and pouring concrete around it. The earth is used to form the concrete and to hold the stanchion in line and grade while is concrete is setting. The cost of the supports is only a fraction of that of conventional piers.



First step in making this inexpensive support is to fabricate a T-shaped stanchion from scrap pipe. The cross member of the stanchion is about four inches longer than the diameter of the pipe header to be supported. The added inches provide room for the U-bolts which will clamp the header in place. Ends of the cross member are closed by welding circular plates inside the pipe.

The vertical member of the stanchion is made of same diameter pipe as the cross member and is cut long enough to extend about 14 inches below bottom of the concrete. It is saddled onto the crossmember in such a way that two pieces of pipe do not contact internally. Two or three pieces of angle iron are welded to the pipe support on the section which will be in concrete. These lugs on the pipe make up for the insufficient area of pipe provided for bonding to concrete.

Two or three days before the piers are poured, the vertical member of the stanchion should be poured full of grout. Since the upper cross member does not connect to the vertical member, the grout will not fill the upper section.

The concrete piers which support the stanchions are sized for "neat" forming. A form made by nailing 2 x 4's together comprises the upper few inches of the stanchion. This form can be held in place by the excavation and braced by stakes driven in the ground some distance from the form.

After excavation has been completed, the stanchions are driven into the ground, the top member set to line and grade. Then the concrete is carefully poured around the stanchions and finished as desired. The result will be a neat and inexpensive installation.

Folding Shade Stand on Tractor Aids Operator

An umbrella is a welcome addition to a tractor on brilliant, sunny days, but it can be a hazard to the operator in cloudy, hazy weather. A folding stand solves the dilemma by permitting the umbrella to be raised when needed as an eye-shade, and lowered back out of the way when it would obstruct the tractor-operator's vision.

The base of the stand is made of a two-inch nipple into which a 14-inch piece of 1-inch pipe is fitted. A set screw on the side of the two-inch pipe enables the operator to tighten the stand, once it is adjusted.

An unusual elbow arrangement allows the stand to be folded out of the way. A 1¼-inch pipe nipple is fitted into a tee welded across the top of the 1½-inch nipple so that the smaller pipe slides inside the 1½-inch. The 1½-inch nipple is flattened and a half-inch hole is drilled through it to match a hole in the flattened end of another nipple. A piece of one-inch pipe is then set into the one-inch nipple and set screw adjusted to allow this section to slide.

To raise the umbrella, it is turned up past center on the joints, and each of the thumb screws is tightened down. The umbrella can then be swung into any desired position.

You can't get caught in this trap!

NO threads to gall or freeze
NO leaky seals
NO doubt about strength—
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NO multi-bolt flanges
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Self-Sealing Gasket—made of Hycar (oil and gas resistant rubber)—is the final answer to scraper trap leaks. Its lipped design makes it self-sealing under line pressure. The coupling cannot be overtightened to the extent of damaging the gasket or the coupling itself.

Release two bolts. Swing the trap open. Take the pig out or put the pig in. Close the trap and tighten two bolts. That's just how simple and easy it is to operate a UNIBOLT Scraper Trap. An oversize barrel (slightly larger than the o.d. of the pig) makes it equally easy to start a pig. Line pressure does the heavy work.

Pipeliners everywhere are using UNIBOLT closures and couplings for scraper traps, blowdowns, strainers, mist removers and other large diameter pressure vessels. A UNIBOLT representative will gladly explain the advantageous features of these products to you.

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Sled Hauls Grease for Spread

Scrap 26-inch pipe can be used to make sleds for moving fuel and lubricants up and down the pipe line. The runners of the big-inch pipe give the sled the buoyancy it needs to ride lightly over muddy right-of-way or float on the water.

The front end of the runners are fabricated from pipe bend with quarter-inch plate welded over the openings. The rear of the runners were mitred with a cutting torch and quarter-inch steel plates welded over the opening to make the skids watertight.

After the runners were made, they were fastened together with four four-inch nipples welded between the runners near the top to form a sturdy float. The fuel tanks were then mounted on angle iron frame to support them. The angle iron frame was then welded fast to the skids.

In operation, a winch tractor is used to draw the unit through marshy places. A connection is made to the winch line on the tractor so that when an "impassable" place is encountered, the winch is thrown out of gear and the tractor driven or pulled through the bad place. The winch is then engaged and the fuel and lubricant float pulled to the tractor.

Labor Saved in Building Forms

A small pointed lug welded in the crook of a nail bar can save time and money in constructing houses and forms for concrete foundations.

The lug enables a carpenter to hook the nail bar into a stud and use it to prize 1 x 8 shiplap or siding tightly in place for nailing. Using the improved bar, a carpenter can align siding and nail it to studs in one operation. Ordinarily the task requires two men, one holding the siding in place, the other driving the nails.

The lug on the nail bar is made of a steel rod, two inches long. It is spaced about 2½ inches from the

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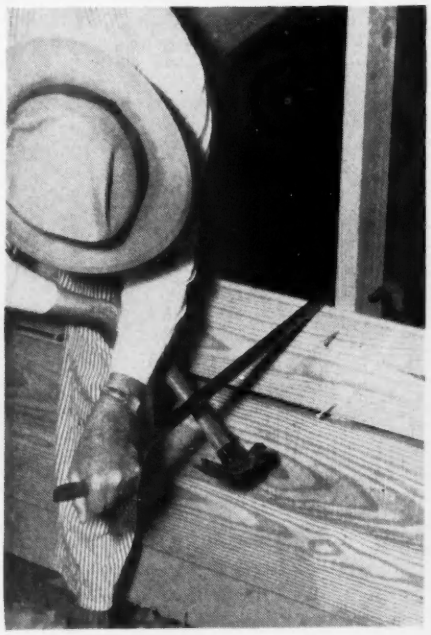

handle of the bar in the crook and welded with the sharpened point facing inward.

To use the device, the carpenter places the head of the bar around the stud, hooks the sharpened point into the stud and then presses downward on the handle to force the siding in place. With his free hand he drives the nails in the stud.

This device, which proves helpful on a compressor or pump station construction job, was developed by R. C. Byerly of Jasper, Texas, a Tennessee Gas Transmission Company construction worker.

Sand Provides Good Boat Deck Footing

Sprinkling sand on newly painted boat decks provides a rough surface for good footing when the decks are wet.

With water transportation playing a vital role in pipelining today, efforts are being made to improve efficiency and safety of small boats. For just a few cents, boat decks can be made less hazardous during wet weather.

After the last coat of paint has been applied to the deck, sprinkle a heavy coat of sand on top of the still wet paint. When the paint has dried, sweep off the excess sand and the resulting surface will be uniformly rough, providing a secure footing for wet weather.

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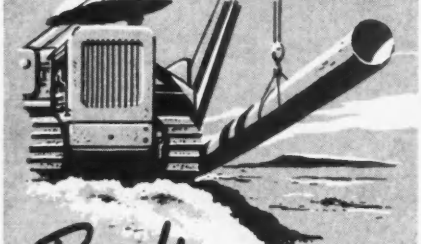

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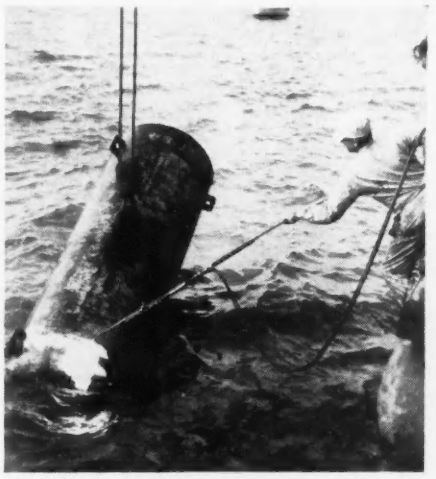
PIPE LINE HINTS

Handle Aids Cutting Pontoons From Line



An extension handle for a burning torch enabled pipeliners to speed removal of pontoons from an underwater pipe line as it was pulled across a channel, and eliminated danger from the pontoons as they were suddenly released.

The pontoons had been attached to the pipe line to lighten the negative buoyancy as the line was pulled into a ditch across a channel. As the pipe was laid in the ditch, the pontoons were removed.

The speed with which the pontoons were removed was of great importance, since the channel could be closed to ocean traffic for only a few hours and the longer the line remained stationary, the harder it was to get started as the pull continued.

Burning the lashings from a safe distance was the safest and quickest means of removing the pontoons. Sending a diver under the surface of the water with burning equipment was safe, but very slow. Cutting the wire from a small boat would have been quick, but unsafe, since the heavily weighted pontoons almost exploded from the water as they were released, and could easily capsize a small boat.

In this operation, workmen in small boats hooked the pontoon to a crane on the work barge and the pontoon was lifted slightly by the crane. A welder using the extension handle on the torch burned the lashings apart from the work barge.

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Arabian American Oil Company unitized drilling rig operating in Saudi Arabia's Ain Dar field. Generator plant, derrick, engine compound, and mud tanks are constructed so they may be moved individually as complete units.

THIS IS the first in a series of articles on current production and prospects in countries of the Middle East by WORLD OIL's international editor, who recently completed a 20,000-mile journey through Middle East oil centers and installations.

Aramco Gauges Billionth Barrel After 14 Years of Production

By DON KLIEWER
WORLD OIL Staff

WAR or peace could hinge on Middle East oil. As long as petroleum remains a major factor in military consideration or peacetime economics, the Middle East will hold a dominant position because of its unlimited resources. Crude production is tremendous; reserves are almost unbelievable; exploration is extensive.

Proof of Middle East's position in the inter-continental rivalry for oil has been its crude production after shutdown of Iranian oil fields in 1951 and the almost complete immobilization of the refinery at Abadan. Gearing itself to an all-out production effort to make up for the approximate 700,000-barrel-a-day loss in Iran with the ousting of Anglo-Iranian Oil Company, the Middle East achieved results which claimed immediate attention of both the East and the West.

Saudi Arabia, major Middle East producer, has climbed from a 1950 daily average of 546,000 barrels to between 900,000 barrels and 950,000 barrels a day. Kuwait is running a close second with a daily output that is nudging the 800,000-barrel level. Iraq, with 1950 yield of 46,760,206 barrels, climbed 14,774,513 barrels in 1951 for a total that year of 61,534,-719 barrels. Kuwait Oil Company is now producing in the neighborhood of 170,000 barrels every 24 hours. Bahrein Petroleum Company is recovering 30,000 barrels daily from the island shiekdom on which it operates.

After 14 years' production and five years' prior exploration, Arabian American Oil Company, sole concessionaire in Saudi Arabia, is producing on its second billion barrels of oil. Early this year, the billionth barrel of oil to flow from Aramco's fields was gauged. Set end to end in the cold reaches of space, these billion drums would stretch to the moon and back.

The great Burgan field, operated by the Kuwait Oil Company, will be extended through the completion of a new well, Magwa 1, which now is awaiting pipe line connections. Magwa 2, 1⅛ miles southeast of Magwa 1, is drilling ahead at 2750 feet, aiming at the Cretaceous at 4700 feet.

Upon completion of Magwa 2 and construction of pipe lines to both new wells, Kuwait's crude production, too, will hinge upon capacity of above-ground installations to handle the flood of crude.

Vast figures from a vast country? Yes, but the immensity of the petroleum resources in the Middle East cannot be properly assessed even yet. Oilwise, this 2000-year-old country is young, but 20th century technocracy, prodded by a blending of the talents of two peoples standing at opposite

This structural drill rig is the southernmost exploration rig operating in the Rub al Khali, the "Empty Quarter," a 280,000-square-mile exploration area in the southern part of the Arabian peninsula. With two local crewmen shown at left are Steel Bennett, Aramco surface geologist; G. H. Smith, driller, and the author.

A street scene a few blocks from Parliament Square in Beirut, Lebanon. Situated on a direct airline route from Rome to Dhahran, free exchange Beirut is replacing violent Cairo as the avenue to the Middle East.

This is one of the DC3's used by Aramco in ferrying personnel and supplies between company headquarters at Dhahran, Saudi Arabia, and exploration sites in the desert.

ends of time's calendar, is speeding up the "aging."

Responsibility of supplying the world market with the thousands of barrels of oil removed from trade channels by the Iranian controversy coupled with the economic objective of making money has led Middle East concessionaires to keep wells producing at high levels, to continue stepout drilling and to send exploration parties throughout their expansive concessions seeking prospective drilling sites. As the stepout wells have been brought in as producers, additional burden has resulted on aboveground production, refining and distribution facilities, which have been operating far beyond their original capacity for months.

With this high crude production and imagination-shattering reserves, figured in billions of barrels, immediate concern throughout the capitals of the world is one of Middle East control, particularly with the neutralization of Iranian crude. However, informed sources throughout the critical areas exhibit no fear that Western concessionaires in Saudi Arabia, Iraq or Kuwait will face any serious trouble in the immediate future, at least. Conjecture has developed, of course, over Iran and the likelihood of its falling into the grasping paws of the Russian bear.

Iran has been hard hit by nationalization. Hundreds of merchants have closed their shops and moved to other Middle Eastern countries where there are prospective buyers with money, a combination that is waning in Iran. The nation is feeling the effects of an 80 percent curtailment in motor transportation. Urban dwellers cannot reach rural areas. Foodstuffs cannot be moved to market. Hardships are mounting, but the Iranians appear determined to weather the critical situation.

It appears doubtful that any power could force its way into Iran and have its will be done, without arousing Moslem wrath to such an extent that the move would not be worthwhile. Iranians will deal with the country that offers them the most profitable working agreement, but they will relinquish no control over their oil without a fight.

That feeling has caused the Kremlin to walk softly and keep its big stick sheathed—even though with a Red foothold in the Middle East and the advantage of Iranian oil the balance of power that has kept the world short of war might be tipped in its favor.

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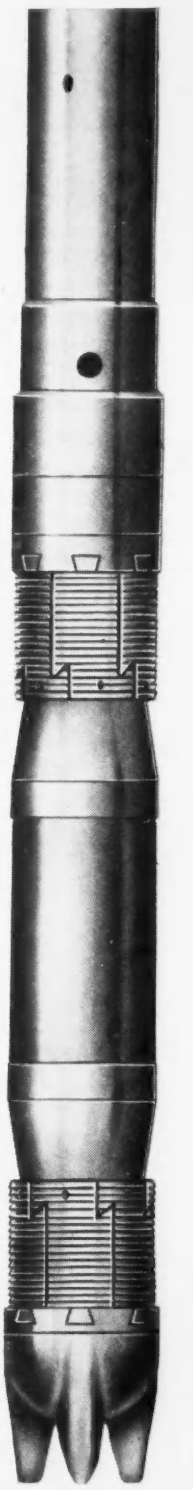

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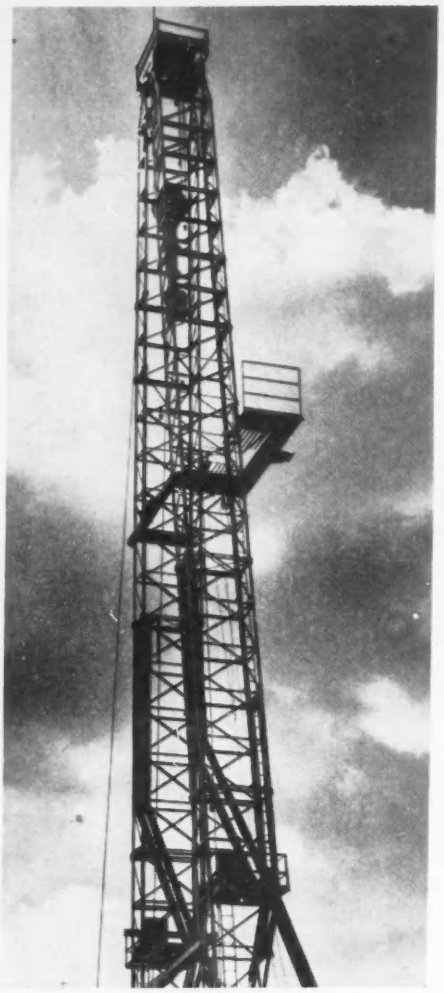


1 Preparing tools for foreign shipment is a tedious and expensive procedure. Each component of the rig must be assembled, operated, torn down and packaged for shipment.

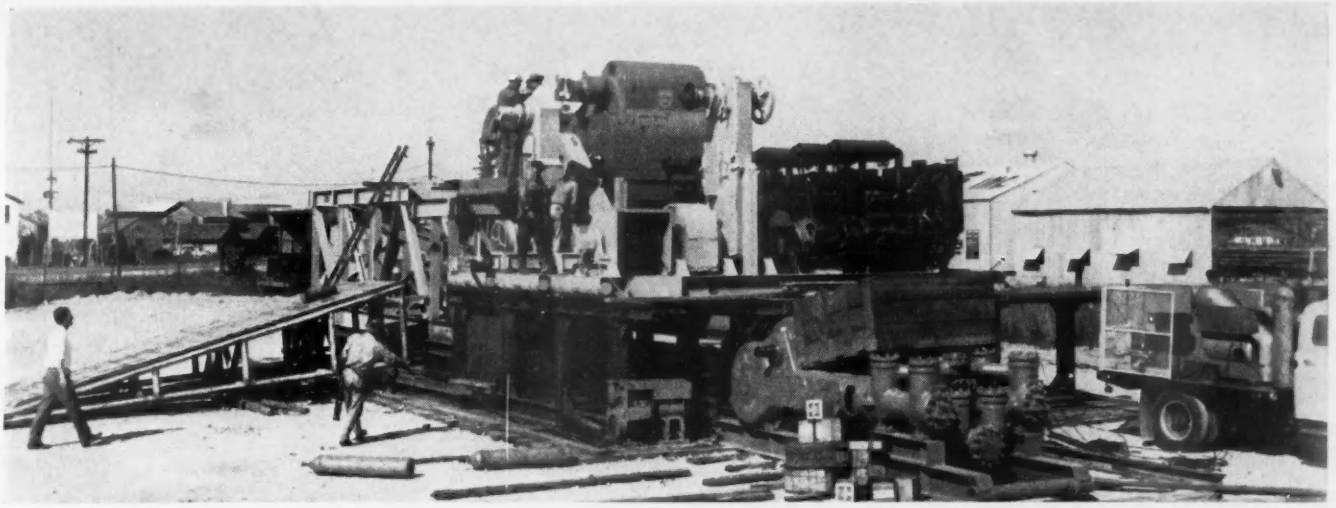
A Short, Dry Run For a Long Wet Trip . . .

PREPARING a drilling rig for foreign shipment is not a simple chore. Since supply stores, rig-up specialists, drilling engineers and extensive machine shop facilities are not commonplace in outlying regions, the operator must complete the process of rigging-up, operating and tearing-down. The program is time consuming and very expensive; however, it is a must for efficient and economical function of drilling tools in far away places.

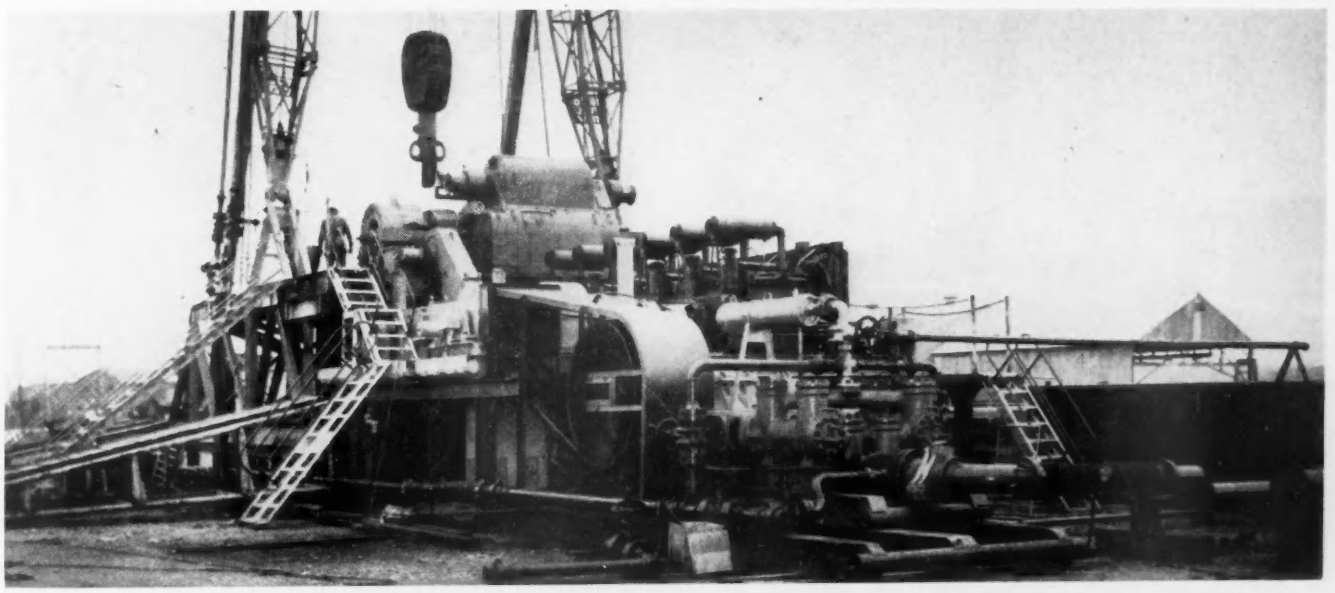
The rig discussed here is destined for South America. Owned by one of the larger foreign operators, the unit has been completely engineered with the basic thought toward simplicity and supplying necessary tools and equipment. Although drilling fluid was not circulated throughout the system, the standpipe and all mud lines were connected and numbered to permit ease in rapid rig-up practice. The procedure involved not only oiling bearings and crankcases but, in some instances, the lubricant was immediately removed to eliminate the possibility of waste in transport.

Coupled with the availability of supplies and the caliber of labor in foreign service, every precaution was taken to equip the rig in a foolproof manner with all necessary standby parts stowed in extra tool houses. Unlike stateside operation, nothing can be overlooked in the process of preparing tools for foreign service since it is not possible to pick up replacement or repair parts at a supply store around the corner. Supplementing paper planning, the complete layout is checked and re-checked before berthing the rig aboard ship.

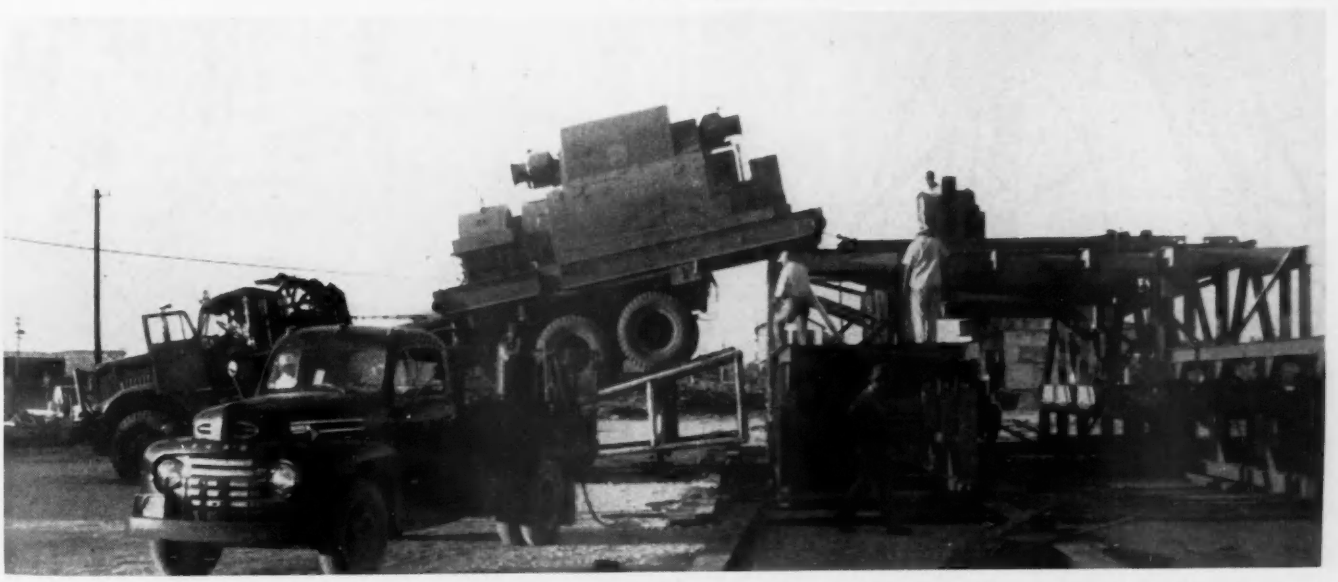
2 BASE STRUCTURE. Step one includes laying matting and placing engine and derrick substructures in their assigned positions. The 'location' must be cleared and leveled as each unit is plumbed and aligned as though a well is to be drilled.



3 DRAWWORKS NEXT. Heavy equipment, including the drawworks, engines, compound, transmission and pumps are then spotted in operating position. Belts, chains and guards are locked in place. No details are overlooked, since even air, water and fuel lines are fastened throughout the system for actual operation of the tools.



4 READY TO GO. The assembled rig is operated to check equipment performance. Even the mast is given a workout for a check of each integral part. All stairways and ramps are stationed in an operating position. The rig is complete, ready to go except for the tool bench and guard rails.



5 TEARING-DOWN. Completion of performance tests is followed by tearing down the rig. Each unit is disassembled into small and compact packages. Not unlike a regular location move, the tools are taken from the shop to port site for ultimate transfer and anchorage within the ship hold.

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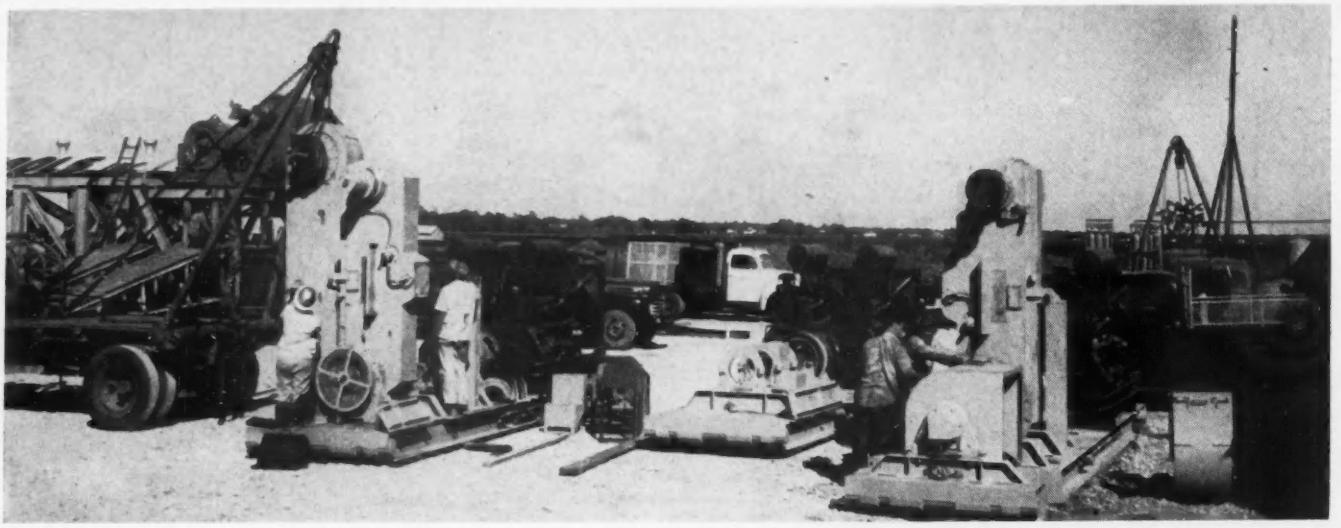
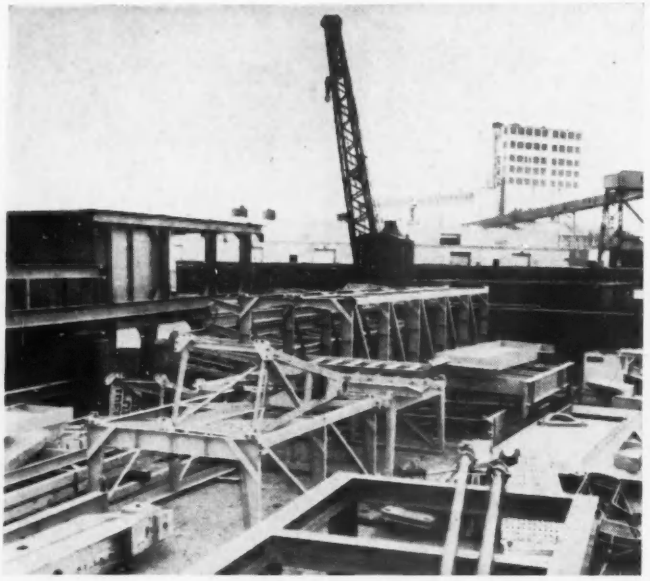
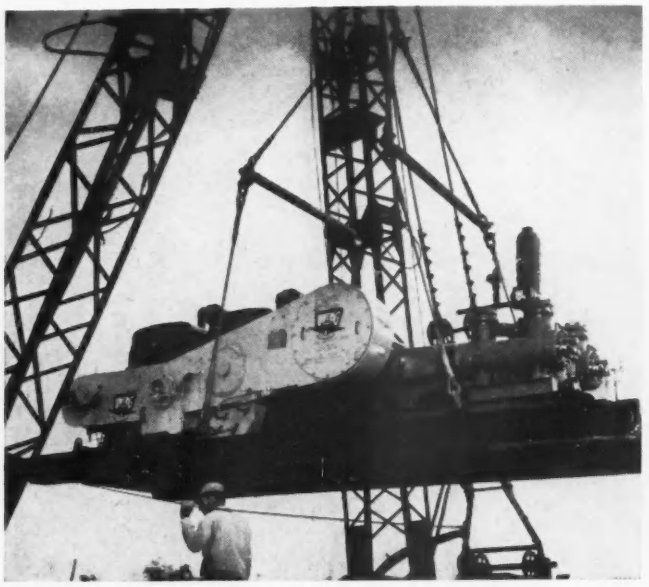


6 COMPOUND PACKAGED. Care must be taken to coat each exposed, machined surface with a water-resistant lubricant. Burlap, metal strap retainers and wooden covers block possible contact by salt water. All moving parts are properly secured to eliminate movement.



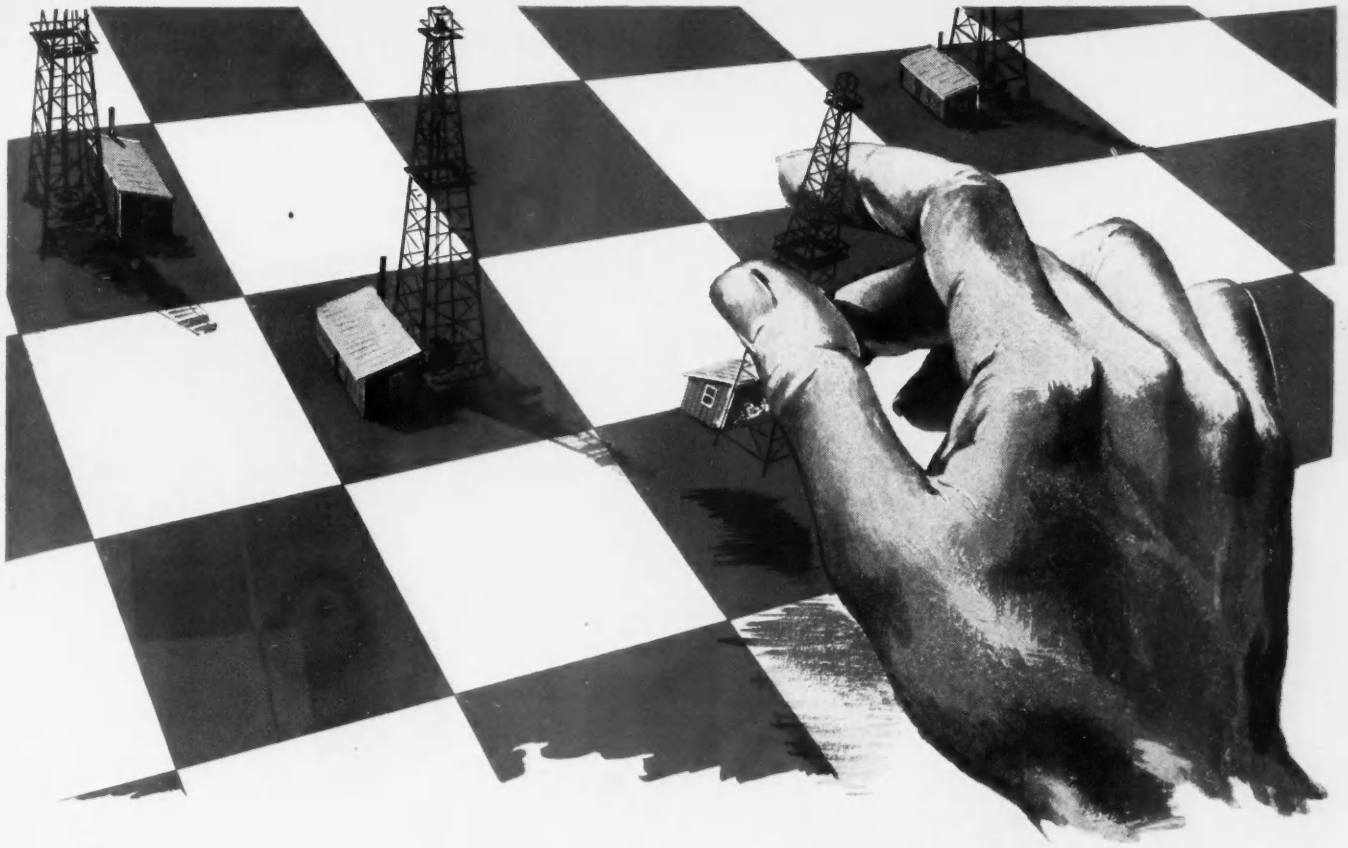
7 ONCE A MAST. Flexible features of the present-day mast permit disassembling to a compact package requiring little space aboard the transferring vessel.

8 HEAVY LOADS FIRST. The drawworks is one of the first pieces of equipment aboard. Slings fastened to heavy duty eyes in the skid beams expedite the process.



9 BERTHING THE MUD PUMP. The completely unitized mud pump is lifted from ground level into the storage area. Each piece of equipment rests upon heavy timber matting and a turnbuckle system governs movement across the deck.

10 A BALANCED LOAD. The process of loading is an exacting technique wherein equipment weights are equally distributed over the vessel deck. The cargo must be perfectly balanced to permit ease in steerage and proper ballast for rough seas.



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Looking east on Second Street from the intersection of Second and Center in the early 1920's.

CASPER, WYO.

. . . Oil Capital of the Rockies

By TOM DOUGHERTY

Oil Editor, The Casper *Tribune-Herald*

FROM the pen of western story writer Zane Grey spilled millions of flavor-filled words of the Old West. Words welded into stories which have thrilled readers from opening paragraph to final roar of a .45. Stories of figures like Buffalo Bill Cody, Calamity Jane, and Bob Devine, foreman of the CY ranch from which the Casper, Wyo., townsite was carved, and who led forays against the storied Hole-in-the-Wall gang. Stories from which dreams are fashioned.

But it was another story and another dream that provided the stepping-stone for Casper's rise to a city of modern prominence from its boisterous beginning as a frontier town.

It was the dream of a man whose vision extended farther than the mountains whose trails he traveled with others who saw an empire in the making—Kit Carson, Jim Bridger and Cimineau Lajeunesse, famous among mountain men of the West.

Cy Iba, prospector, pioneer, miner, frontiersman, discovered oil seeps in the Seminoe Mountain country west of Casper during his travels in 1851. Remembering them, he followed the flow of emigration westward, did a stint of placer mining in Alaska, and returned to his beloved Black Hills of South Dakota. But he found no peace; his unflagging interest in oil led him to return to the Seminoe country and Casper to locate oil claims. Among his Salt Creek claims was the famous "Iba Eighty," one of the richest producing areas in the Shannon pool, about 45 miles north of Casper, and chief cornerstone of the fortune his widow left at her death early in 1951.

Iba's efforts to enlist eastern capital, required for further development of the oil seeps, succeeded in 1889, when several individuals, among them P. M. Shannon, president of the Pennsylvania Oil & Gas Company, staked Salt Creek claims covering 14,000 acres. The first wildcat was spudded in the following fall, and completed in the spring of 1890 at a depth of 1090 feet as the Shannon pool discovery.

Casper residents smiled with deep satisfaction on February 10, 1894, as they read in their newspaper, the *Wyoming Derrick*, that their town was "the liveliest in the state" and that "business of every kind was good." Reason for the optimism: Four stud poker games were going full blast at one time.

This succinct appraisal was voiced six years after the first buildings were erected inside the present city limits, and four years after the Pennsylvania Oil & Gas Company spudded in the first Shannon well, just north of the then undiscovered Salt Creek field. At the close of 1896 eight wells had been drilled in the field, all good producers at depths ranging from 600 to 1100 feet.

And so it was that Casper gradually changed character and appearance. Cowtown Casper was becoming Oiltown Casper. Beginning their eternal slide into history were frontier

This is a snow and water covered Casper street familiar to residents of 1909.

The W. F. Henning mansion, built during Casper's early boom days, was decorated with imported woods, marbles, floor coverings and draperies. Henning, who went to Casper as a plumber, remained to acquire extensive properties there.

Center street looking north from Second at the beginning of the 1920's. The courthouse in the center distance has been replaced by a modern city-county building, located to the left of the old site, and built during the 1930's.

The old Franco-Wyoming refinery east of Casper, which was built after acquisition by Franco-Wyoming of properties held by an American-Belgian firm. Franco-Wyoming later merged with Midwest Oil Company.

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characteristics which the passing parade of frontiersmen took with them elsewhere. Ruby lights of the "Sandbar" burned lower. At one time in 1889, Casper was labeled a "Sunday school town" because of an ordinance forbidding women to appear in bars save between 10 p.m. and 7 a.m. The allotted hours were put to such uproarious use that public sentiment and lack of sleep soon led to the forcible ejection from town of much of the shady element.

The city's drive toward its current prominence, which was to experience a stumble later on, quickened in the 1890's. String freight teams continuously hauled crude to Casper and loaded with supplies on return trips to the field. Wyoming's first refinery was built at Casper in 1895 with a capacity of 50 to 100 barrels daily.

In 1903 the Societe Belgo-American des Petroles du Wyoming bought the holdings of the Pennsylvania Oil & Gas Company, and announced plans for a railroad from Cheyenne to Lander and from Casper to the Salt Creek field. After exciting high hopes of immediate development, the company's plans folded from within and Casper's oil business lagged considerably until 1910, when Franco-Wyoming Oil Company bought the defunct Belgian firm's assets, built a refinery at Casper, and began operations on what was then described as an extensive scale.

Also in 1910, Midwest Oil Company was incorporated and began operating as a rival of Franco-Wyoming in the Salt Creek field. Four years later, the rival companies merged under the name of Midwest Refining Company, with facilities for a daily crude charge of 12,800 barrels at the Casper refinery. By 1920, Midwest had a daily refinery capacity of 46,900 barrels and storage facilities for 2½ million barrels at Casper and in the field. It was the dominant oil company in the Rocky Mountains. And more than one present-day resident of Casper is comfortably fixed financially through ownership of Midwest Refining stock which pyramided in value in a short time.

Standard Oil Company (Indiana) entered the Casper scene in 1913 with the acquisition of 84 acres on the west edge of town, part of the site of the present plant. By 1921, Standard's operation had progressed to such an extent that Midwest Refining was absorbed with proceeds of a $30 million stock issue voted by Standard stockholders. During 1922 Standard operated at near capacity at the Casper plant and shipped two 19,000-barrel trainloads of gasoline weekly to Gulf ports for export to fulfill a 2 million barrel annual gasoline contract abroad.

Standard's average crude input during 1922 was 45,000 barrels a day, and the plant's gasoline production then rated it as the largest gasoline operation in the world.

Between the cemetery in the foreground and the Standard Oil Company (Indiana) refinery and the tank farm in the background lies Casper's residential section and business district. U. S. Highway 20 goes through Casper's business district (at extreme right) and crosses the North Platte River near the refinery.

Also in the boom year of 1922, The Texas Company located a refinery on a 640-acre site just east of Casper, after scrapping plans to build the plant near Glenrock, about 24 miles farther east where Continental Oil Company now has a refinery.

Casper reached a peak of development in the early 1900's. From a sagebrush wasteland in 1888, the city grew to a population of 27,000; had an assessed valuation of $27 million, all accomplished on oil economy. Salt Creek field north of Casper and Big Muddy field to the east, which was discovered in 1916, were the most important developments in the city's history to that date.

Like the frontier era before it, the oil business at Casper had its unorthodox moments in the beginning. Many development claims of the Salt Creek area were proved up by the might of a six-gun rather than the right of justice. Not a few would-be oil men changed their profession on the spot when the dark, dangerous recess of a gun barrel was shoved their way. By contrast, honesty which prevailed during the leasing and oil stock craze of 1916-17 was astonishing.

During most of those two years, many men neglected their calling to traffic in oil stocks. The lobby of the Midwest (now Henning) Hotel was the site of much trading. The sidewalk or lobby served as stock exchange Scores of brokers with pockets bulging with stocks cleared from $100 to $1000 a day. Oil companies were a dime a dozen, with new ones formed every day. Some prospered and paid investors handsomely. Most didn't.

By the fall of 1917 many brokers and investors had returned to their previous businesses, and Casper's biggest oil stock boom in history faded. Taking their cue from the stock business, other businesses skidded with a sudden rush which brings shudders from long-time Casper residents even today.

Prosperity had depended on oil markets. Several factors hamstrung those markets at one fell swoop: a sharp differential in prices paid for Wyoming and Mid-Continent oil, climbing transportation costs, rising availability of Mid-Continent crude.

Accordingly, population slipped to 17,000 by 1930, was but slightly higher ten years later. At the end of World War II, the Rocky Mountain region began to experience an exploration and development boom which steadily gained momentum except for a short period in 1949. The impact of the heightened Rocky Mountain interest was quickly transmitted to Cas-

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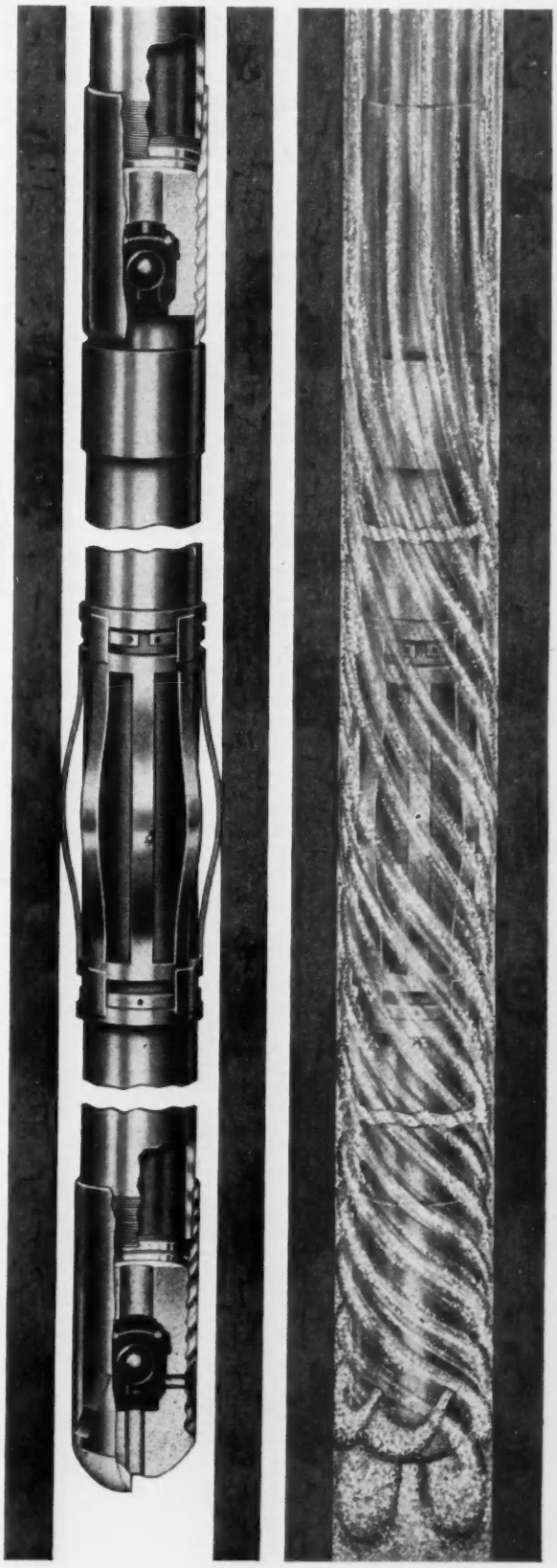
THE DOWNWARD HYDRAULICKING ACTION of the fluid through the baffled, side down-whirler ports of a Baker Whirler Shoe, and through the nozzle-like bottom outlet, effectively removes bridges and permits safe running of the casing.

When washing the formation at the cementing point to condition the hole, the "whirling" motion of the fluid helps remove mud cake from the side walls. This *downward* whirling is far superior to any *side* jetting action.



The view at far right shows the "whirling" motion given to the cement slurry as it is discharged from a Baker Cement Wash-Down WHIRLER Float Shoe, with the shoe joint centered by means of a Baker Model "G" Casing Centralizer. *This same whirling motion given to the circulating fluid, conditions and prepares the wall of the hole immediately prior to the discharge of the slurry.* The whirling action of the slurry, in turn, not only supplements the hole conditioning process, but also ensures that the centered casing will be completely encased with a uniform body of cement and that the hazard of channeling will be reduced to a minimum.

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KEY TO CEMENTING SUCCESS

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per, which began to flex its muscles for another shot at prosperity.

Basement apartments and other rental units which had housed servicemen and their families during the war were pressed into service. Pressure for new housing grew and a major building spree started. Lots vacant in 1945 today are sites of newly-erected houses. Additions have been made all around the city's perimeter, but demand for housing is far from satisfied.

Office space is another problem for dozens of firms. Several new buildings have been erected during the past five years, primarily to afford space to oil businesses. The Ohio Oil Company completed a modern four-story headquarters for its Rocky Mountain operations. The Star building, another new one, is devoted to oil men.

Since 1946 building permits have reached a total of $22,638,096, including an ambitious expansion program in the school system which found classrooms overflowing with newcomers. Casper's 13 schools include a high school, junior high, junior college, in addition to grammar and parochial schools. Casper Junior College has become a highly respected asset to the community since its establishment in 1946. In addition to regular academic courses, it provides night classes for adults on subjects ranging from English composition to drilling mud, from drafting to international economics and square dancing.

New Wyoming oil discoveries since the war have set the tempo for Casper. At Sussex-Meadow Creek to the north a major field has developed since 1947. That area has led the entire Rocky Mountain region in development work during the past three years. Discovery of oil at Glenrock and at South Glenrock in the East Big Muddy field, in new Cole Creek and Sage Spring Creek areas has strengthened Casper's economy. Further development of the Big Horn Basin in the north-central portion of the state, wildcat strikes on Wyoming's western border, the probing to deeper horizons in various areas of the state, and the exploratory and development work in surrounding states has boosted activity in the Rocky Mountain Oil Capital.

A majority of the oil activity ranging southward from the new boom in the Williston Basin to the heavy drilling in the Julesburg Basin, westward into Utah, and over the entire state of Wyoming is largely controlled and directed from Casper offices. The city is also the service and supply center of the area, with major supply and service firms represented on a substantial scale.

Refining has kept pace. During the immediate postwar years, Casper's three refineries, operated by Texaco, Standard of Indiana and Socony-Vacuum Oil Company, added catalytic cracking units. They are now operating almost at capacity to satisfy a growing regional demand, and their payrolls are the mainstay of Casper's business.

Early in 1951, Wyoming passed the 200,000-barrel per day production mark for the first time, although estimates indicate that 300,000 barrels daily could flow from Wyoming wells without field damage if transportation were available.

Best news to residents in a long time was the announcement early in 1951 that five major companies had joined forces to form the Platte Pipeline Company, with a 20-inch line scheduled from Worland to Wood River, Ill.

No single development in many years has done more to spur oil activity and business in general than news of the Platte line, which will carry upwards of 100,000 barrels of crude daily and can increase capacity to 150,000 barrels by additional pump stations and by looping. Indications are that the 100,000-barrel input will be too small to carry the region's surplus.

From the beginning of Casper's current boom, many oldtimers warned that the new houses would soon stand empty as once before, that investors would be bankrupt, and that grass would virtually grow in the streets.

"I saw it happen before," they said.

But Casper has the homes, schools, churches, civic interest and spirit which make it a good place in which to live.

Its outlook is vigorous. Pessimists who wanted to content themselves with one horse and buggy are on the sidelines, still wondering if the city could support the four stud poker games of 1894.

They don't know it, perhaps, but Casper is playing, even dealing, in one of the biggest games the oil business ever backed.

One of Casper's three modern hotels. The seven stories of this building make it the tallest in the state.

About the Author

TOM DOUGHERTY, oil editor of the Casper, Wyo, Tribune-Herald, became interested in oil when he returned to Wyoming after World War II. By listening, studying and learning, he has found oil reporting "the most fascinating field in journalism." Dougherty quit newspapering to try his hand at teaching, selling and construction work, but after a three-year stint as a Casper High School teacher he went back into newspaper work "where I belong." Stationed at Casper during the war, he liked the country and returned after the war and now has "all the faith in the world in Casper and the Rockies." He is 31 and the father of three children.

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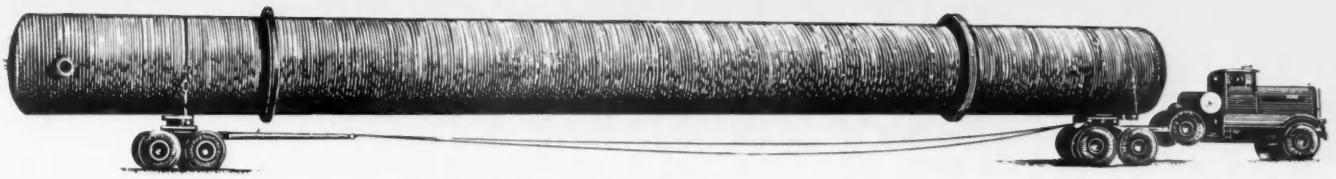
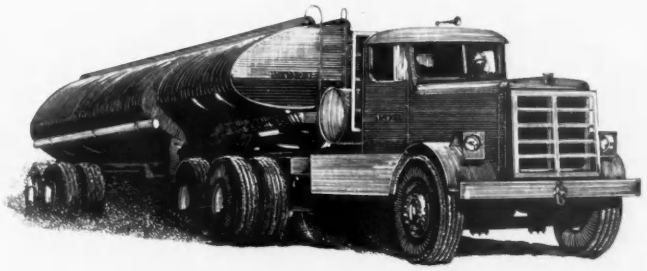
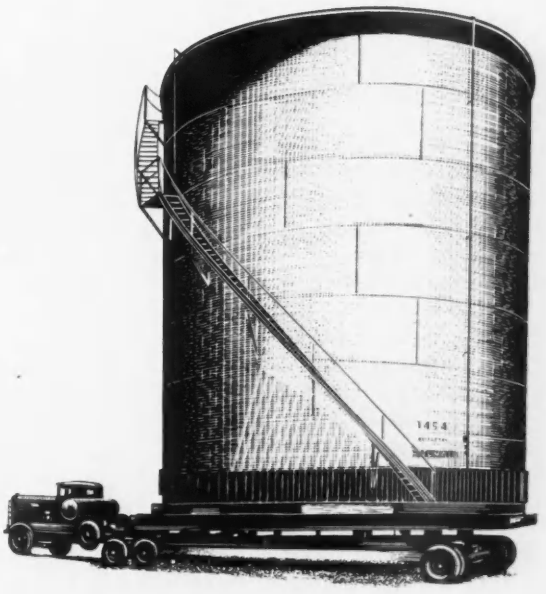


Hauling 100-ton gas trap from Dhahran to Abqaiq, 45 miles away.

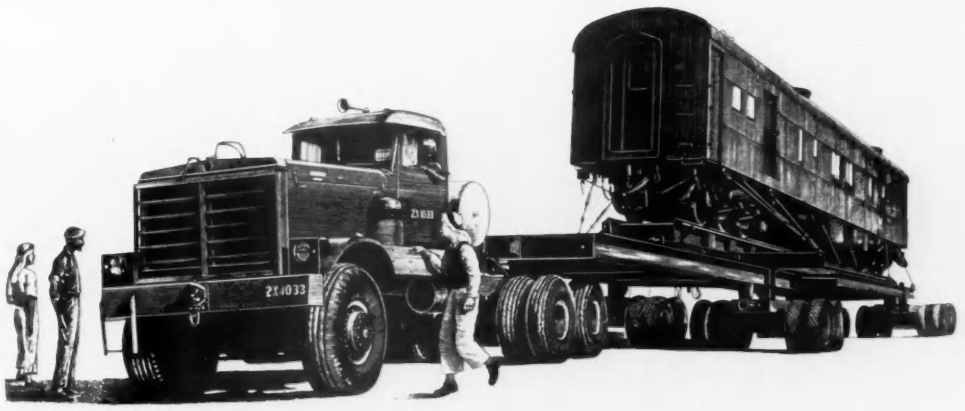


Tank trucks transport fuel or water.



Mammoth trailer moves 7500-barrel tank.

A sedan with sand tires.



Rolling stock for new railroad on a special trailer with double sand tires.

Truck and trailer carrying Arab employes and supplies.

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Electrostatic Treating of Heavy Venezuela Crude

By CHARLES G. JUDGE

Mene Grande Oil Company, Western Division, Venezuela

DEHYDRATION of the wet heavy oil produced from Bolivar Coastal field holdings has taken a new turn. On March 18, 1947, the first electrostatic dehydration installation was completed in Lagunillas field. Others have been added since, and enlargements were constructed with the result that all chemical excelsior plants were put out of operation by 1949. This article summarizes advances made through the electrostatic dehydration facilities now in operation in the area.

DEHYDRATION of wet heavy crudes produced from Mene Grande Oil Company's Bolivar Coastal field holdings in Western Venezuela has presented operating problems since 1929, five years after the field's discovery.

The first Mene Grande wet oil treating program put into operation entailed treatment of wet Lagunillas grade crude at individual gathering stations in the Lagunillas field. Small oil field boilers were utilized as direct-fired heaters to heat the wet oil to approximately 160° F. and a dehydration chemical was introduced before the oil was processed through excelsior-packed tanks.

The first electrostatic dehydration installation was completed in Lagunillas March 18, 1947. Installations have since been made at Taparito and Tasajeras, and enlargements added as necessary with the result that all chemical excelsior plants were out of operation by the summer of 1949.

Mene Grande's producing parcels in the Bolivar Coastal fields consist of a strip 3275 feet wide at the maximum, stretching about 60 miles north and south paralleling the eastern shore of Lake Maracaibo. In general, the wells are in the lake in water varying in depth from 2 to 30 feet.

The wet crudes of the asphalt-base type produced may be grouped as shown in Table 1.

Laguin and Bachaquero grades are not presently marketed as such, but are blended in various proportions. These, then, are the wet heavy crudes as produced by the Mene Grande from the Bolivar Coastal fields of western Venezuela.

A brief resume of electrostatic dehydration facilities follows:

Taparito: Four type "B" electrostatic dehydrators—average plant throughput about 7000 gross barrels per day of 15.9 gravity crude containing about 11 percent basic sediment and water on the inlet side.

Tasajeras: Three type "B" electrostatic dehydrators—average plant throughput about 4500 gross barrels per day of 15.5 gravity crude containing about 16 percent bs&w on the inlet side.

Lagunillas: Six type "A" electrostatic dehydrators and two type "B," scheduled for conversion to type "A." Average plant throughput about 14,000 gross barrels per day of 16.5 gravity crude containing about 11 percent bs&w on the inlet side. (Experience has shown slight variance in operational efficiency and performance between types "A" and "B" units.)

VISCOSITY. In that less viscous crudes permit coalesced water to drop more rapidly during electrostatic dehydration than more viscous crudes, it has been observed that by increasing the temperature of the crude, increased plant efficiency should result. By maintaining constant throughput rates, a measure of this efficiency is obtainable from the clean oil cuts.

TABLE I

GRADE	Average API Gravity 60° F.	Production Gross BPD	Average BS&W Content 2/1/5
Tia Juana	15.0—16.0	7000	20%
Lagunillas*	15.0—17.0	8500	18%
Bachaquero†	10.5—12.0	5000	11%
Laguin	18.0—19.0	4500	3%

* Includes about 1000 bbls. per day Lagunillas Tar.
† Lago parcel only.

However, since excessive temperature will cause accelerated liberation of entrained and dissolved gases with resultant foaming, it follows that when these gases are present the optimum treating temperature will be within a range which represents conditions of maximum Saybolt Universal Seconds viscosity values and minimum gas liberation tendencies. Field operations have substantiated this fact. (Representative viscosities of the various produced crudes are shown with their temperature relations on Figure 1.)

PRESSURE. Not much study has yet been directed toward the effect of varying the back pressure on the electrostatic dehydrating operation. Whenever tests are made, back pressures are varied in an effort to obtain pertinent data, but to date no definite conclusions can be drawn. It is known that for a given set of operating conditions there exists a minimum optimum pressure. Below this value, excessive foaming probably results when gases are present, with consequent poor dehydration, but when the pressure is increased by manipulation of the back pressure valves, no variance in operations efficiency is noted in field data between this minimum value and the designed maximum operating pressure.

GRAVITY. In the electrostatic dehydration operation the coalesced drops of water settle out because of a gravity differential between the light oil and the heavier water. As the gravity of the oil approaches the gravity of the water, the rate of settling will diminish. In Figure 2, field data have been plotted to show this gravity throughput relationship. In plotting these data the method of least squares was utilized to give a linear relationship between the two variables within the indicated limits; however, subsequent field data have further substantiated the relationship. It should be noted that higher throughput rates are possible on the heavy crudes. Figure 2 merely gives a mean value of

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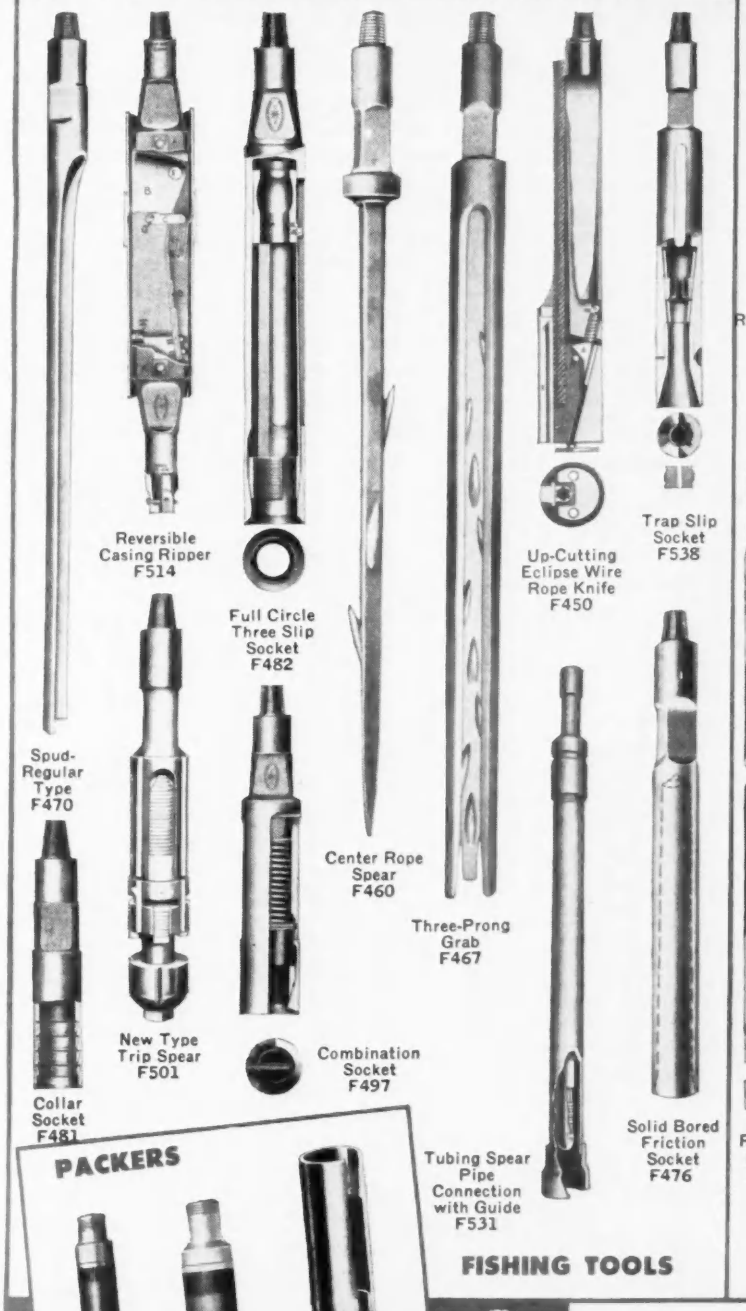
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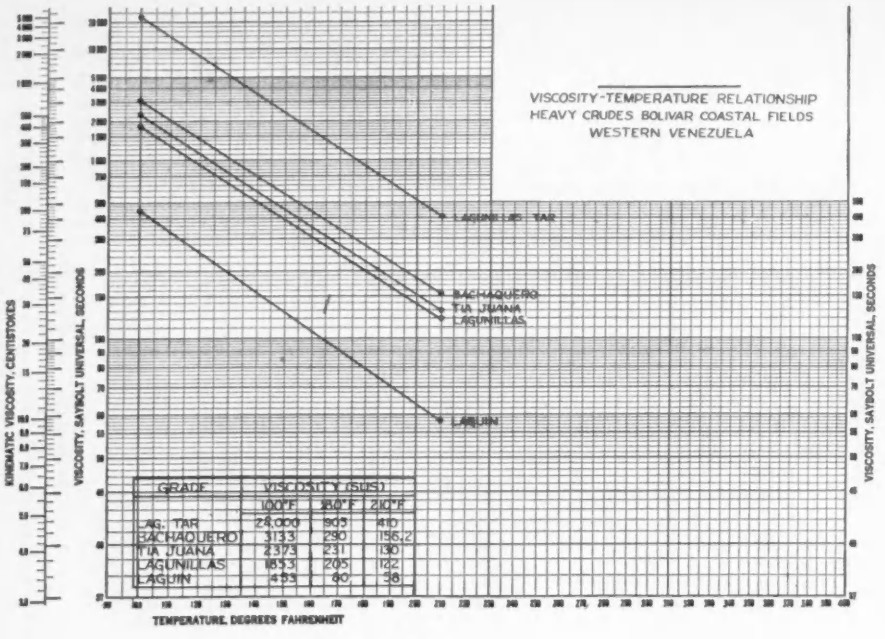

FIGURE 1.

what throughput rates can be expected over extended periods of time.

VOLTAGE. The basic operating principle of electrostatic dehydration is providing an electrostatic field of sufficiently high potential to cause the electrically-charged water particles of a water-in-oil emulsion to rupture the separating oil films and coalesce into larger drops which settle out by gravity. To perform this function, a field is provided between live and grounded electrodes through which the oil to be treated must pass.

Satisfactory field results have been obtained by utilizing electrodes supplied by the unit manufacturer. Where locally designed electrodes are presently employed, increased operating efficiencies are probably the result of the prevention of channeling untreated oil around the field rather than any inherent improvement in the basic design of the electrode itself. Although improved operating efficiencies have resulted by increasing the voltage being applied to the electrode, the electrode spacing has not been a critical factor in treating these heavy crudes.

CHEMICAL ADDITIVES. From the inception by Mene Grande of the electrostatic method of dehydration, experimentation has been periodically performed to determine what effect the addition of dehydrating chemicals had on the operation. To date, no benefits have been realized. Chemical ratios have been varied within range of economic feasibility, and several different brands of chemicals have been used; but no increase in process efficiency has yet been observed. There is an advantage in that the small amount of oil that comes over with the water in the discharge of the operation separates more quickly in the sump pit, but high chemical cost prohibits the use of it for this purpose alone. At present chemical is being experimentally injected into a 14.5-gravity blend of Laguin and Bachaquero grade crudes in an effort to permit higher throughput rates. Thus, the use of chemical has not yet been ruled out, and much experimentation remains to be done with even the better known brands of dehydrating chemicals on the market.

HEATERS. On the Lago parcel, a portion of the Bachaquero crude is subjected to heat at each of the three lake gathering stations prior to pumping into the lateral discharge lines. This operation is performed by steam coils within the storage tanks and the heating is designed to facilitate the pumping operation. A secondary but nevertheless important result is obtained in the separation of a quantity of the produced free water. Furthermore, at both the Lagunillas and Taparito terminals, the 55,000-barrel wet oil storage tanks are similarly equipped with steam coils. With these coils, the bulk of the remaining free water is knocked out so that the crude leaving these tanks usually contains only a small percentage of the free water initially produced. The oil is heated to 130-150° F. by these coils and field performance data indicate no adverse results from this heating in conjunction with the electrostatic process. No consideration will be given herein to the loss of light ends, since subsequent heating results in higher temperatures. This heating in storage is also considered desirable in that sand content is more readily dropped, thus reducing to a minimum the deposition in the electrostatic units.

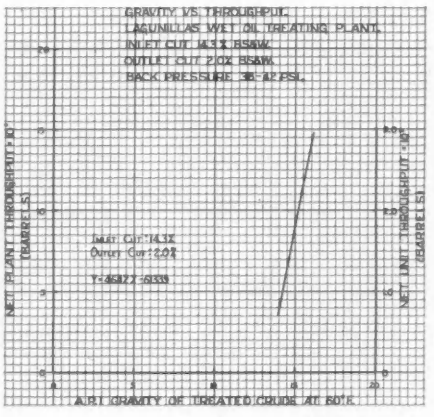

FIGURE 2.

Direct-fired heaters used to heat crude immediately prior to electrostatic dehydration are of two types—those in which the crude is heated by contact with hot flue gases around tubes through which the crude is routed and those in which the crude is heated by contact with the hot surface of fire tubes. Field operations have indicated that the former is more advantageous. However, comparative testing between the two has not yet been completed. It is thought that the advantages realized by the former are due rather to test conditions than to inherent design.

Without doubt, preheating operations contain many additional ramifications which are not easily apparent in field operations and which require additional study.

PUMPS. The Lagunillas wet oil treating plant is equipped with two sets of pumps to charge the wet heavy crudes from storage to the heaters and treaters: a battery of four piston-type pumps and a battery of three centrifugal-type pumps. During the course of normal operations, line samples have been taken to determine the comparative emulsifying effects of each.

It has been observed that the centrifugal pumps have a greater emulsifying effect, and for this reason the use of centrifugal pumps tends to lessen the throughput of the electrostatic dehydrator.

HEAT EXCHANGERS. During the process of electrostatic dehydration, little or no heat is lost from the crude while it is within the insulated dehydrating unit. Thus, there is indicated a method of reducing the total heating requirements of the line preheaters by installing heat exchanger in

the line whereby heat would be transferred from the hot, dehydrated crude to the relatively cold emulsified crude just prior to line preheating. With this thought in mind, a locally made exchanger was installed at the dehydrating plant in Lagunillas, but its operation has not been too successful.

The temperature differential between the two crudes is only 25 to 30 degrees and the transfer properties of the installed exchanger result in only several degrees of heat exchange, insufficient to materially reduce the number of line preheaters required. However, with discontinuance of preliminary steam coil heating in the 55,000-barrel oil storage tanks or with the increase in temperature requirements in treating increased quantities of the heavy Bachaquero grade crude, a heat exchanger will definitely become more feasible, both operating-wise and economically.

SEPARATORS. No gas-oil separation facilities have been installed at any of the three electrostatic dehydration plants in the Lake Basin; however, one equipment manufacturer has recommended this step in conjunction with treating the heavier grades of crude. The theory is that by installing a separator in the charging line between heaters and treaters, higher temperatures can be maintained in the treaters without resultant rolling, thus obtaining more rapid water-oil separation rates and increased operations efficiency. The separated gases would then be re-injected into the discharge stream from the treaters prior to charging into the heat exchanger to avoid the loss of the lighter ends. No plans have been made for inclusion of this additional step in present or future plants; but, without doubt, it remains an important consideration.

Maintenance Operations

Both types of electrostatic dehydrators operate on relatively trouble-free standards. Complete records of downtime during normal operations have not been kept, so a detailed analysis is not possible. In comparison with the old chemical-excelsior type plants which required a three-week downtime period every six to nine months to repack the tanks, the record is good.

The number of sand cleanout jobs required by the electrostatic dehydrating units is, of course, a function of the amount of sand introduced into the units themselves. It is a general policy to produce as little sand as possible to lessen the costly manpower required to service miles of flow and gathering lines and small oil storage tanks. Hence, the volume of sand produced is at a minimum. With an average sand content of less than 0.5 percent introduced into the electrostatic units, a cleanout operation is desirable every six months.

Wet oil storage facilities are such that production curtailment is not required during the requisite two to three-day downtime period. Furthermore, whenever plants are shut down for extended periods of time for other reasons, such as a general production curtailment, this time is used for cleaning operations. In no case is it deemed desirable to await the indication of increasing bs&w treated oil cuts to clean out the units. Hence, there is little indication in the operating data in regard to increased

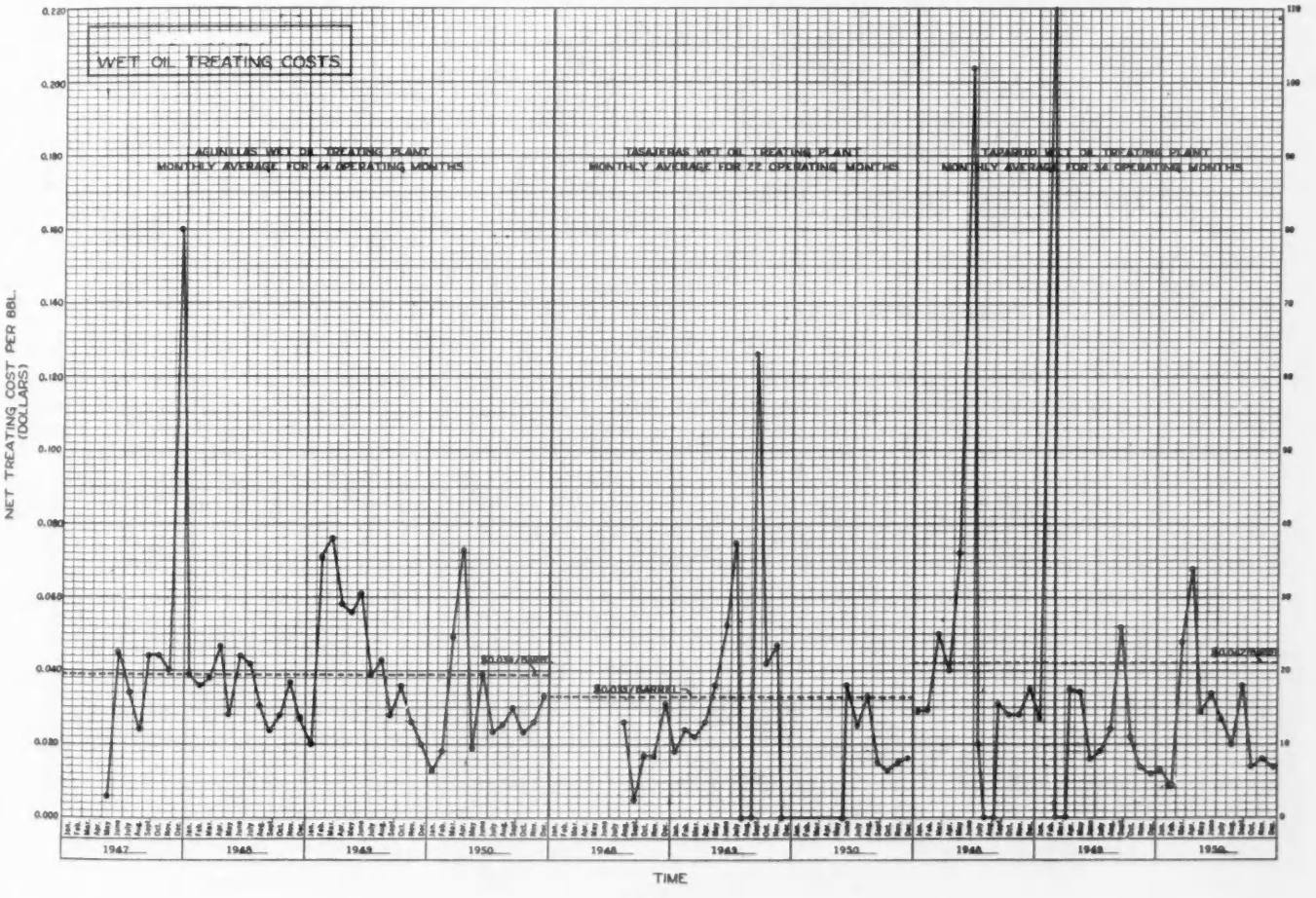

FIGURE 3.

throughputs or decreased cuts resulting from cleanout operations.

The other main causes of downtime are burned-out bushings and insulators. Bushing failures average two per year per unit for the Type A unit and one-half per year per unit for the Type B unit. Insulator failures occurred more frequently on the Type B units until larger sizes were installed during the spring of 1950. Since that time, failures have been reduced to almost zero.

Thus, it can be said that operating failures in electrostatic dehydrating equipment are at a minimum. As a rule, the units require only expected maintenance operations.

Cost

Since the increments of cost vary considerably between domestic and foreign operations and since it is only the total cost of the produced barrel of crude which influences the profitability of oil field operations, no attempt will be made to analyze wet oil treating costs as a percentage of total costs. Yet a survey of the total wet oil treating costs is in order. Figure 3 shows the wet oil treating costs at the Lagunillas, Tasajeras and Taparito wet oil treating plants. The total figure in each instance is composed of the following direct and apportioned charges: Labor, transportation, hauling, fuel, power, electricity, water, chemical, oil, grease and other supplies, insurance and losses, depreciation, indirect labor, maintenance labor, maintenance supplies and other maintenance charges.

It is quickly noted that although the average monthly costs vary between only $0.033 and $0.042 per net barrel, various individual monthly costs vary from $0.005 to $0.225 per net barrel. These peaks of high per barrel costs (over $0.05) can be related directly to either charges from direct expense charges, testing programs or reduced plant throughput. Of these three, the latter is most important from the operating point of view. Since certain charges are regularly made against the wet oil treating installations regardless of plant throughput (operating labor, depreciation, etc.), lower per barrel costs result when maximum plant throughput is realized. Thus, those factors which influence plant throughput such as gravity and bs&w content also have a decided effect on per barrel net cost.

ACKNOWLEDGMENT

This article an excerpt from paper presented at Sixth Production Engineering Conference, Gulf Oil Corporation, in Pittsburgh.

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Wizard Lake Wildcat Taps Thickest Devonian Section

The thickest D-3 Devonian reef ever encountered in Canada has been opened up at a wildcat 6½ miles south of Wizard Lake, scene of Alberta's best Devonian discovery in 1951.

To be placed on production after opening up 735 feet of productive reef was Texaco Bonnie Glen 1, drilled by Texaco Exploration Company and McColl-Frontenac Oil Company, Ltd. The same team made the Wizard Lake discovery last year.

The D-3 section at Bonnie Glen 1 is composed of 300 feet of oil-bearing formation and a 435-foot gas cap. In drill-stem tests, the D-3 yielded 42-gravity crude. From the gas cap, production included high grade naphtha.

Engineers estimated that the well could make more than 100 million cubic feet daily.

Texaco and McColl-Frontenac hold a 50-50 interest in the discovery and in the half-section on which the well is located. Other acreage in the area is held 90 percent by Texaco and 10 percent by McColl-Frontenac.

Of World Oil Men

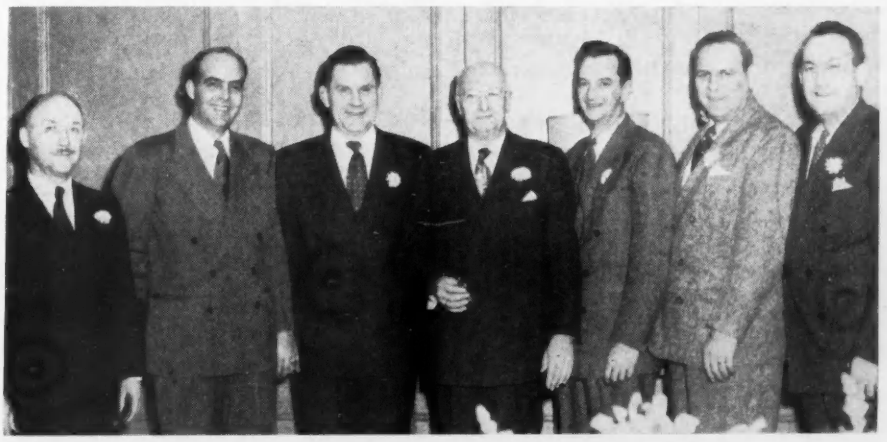
R. L. KEYES has been elected president and a member of the board of the Arabian American Oil Company. He succeeds W. F. MOORE, who retired. Keyes has been assistant general manager of the Producing department of The Texas Company office in Houston since June, 1951.

R. L. Keyes

A native of California, he was graduated from Pomona College and later studied at the University of California and Columbia University.

Keyes joined Texaco in 1926 as a petroleum engineer and later held many responsible jobs along the line. In 1941 he was transferred to New Orleans as manager of the producing department's Arkansas-Louisiana division. He was in New Orleans until his transfer to Houston last year.

His headquarters as president of Aramco will be in Dhahran, Saudi Arabia.



NEW PRESIDENT of the New York Chapter of Nomads is A. A. Dill of Axelson Manufacturing Company. Other new officers are Vice President Russ V. McIntire, Baker Oil Tools, Inc.; Secretary Jesse E. Hickman, Beckley, Haltom and Hickman; Assistant Secretary O. B. Latrobe, Hughes Tool Company; Treasurer E. R. Smoley, The Lummus Company; Assistant Treasurer Don E. Kircher, Gardner-Denver Company; Sergeant-at-Arms C. P. MacDonald, Parkersburg Rig & Reel Company; Assistant Sergeant-at-Arms Edmund Burke, Jr., General Motors Overseas Operations; Regent Henry J. McAdams, Jones & Laughlin Supply Company, and Regent Howard B. Book, Reed Roller Bit Company. Pictured, left to right, are Book, Hickman, McIntire, Dill, MacDonald, Burke and Latrobe.

DR. G. M. LEES, chief geologist of the Anglo-Iranian Oil Company, and C. E. HOBLEY, chief geologist of the Anglo-Saxon Oil Company, are back in London after a visit to the heart of the Nigerian bush.

They inspected drilling operations by Shell D'Arcy Development Company of Nigeria, jointly owned by Anglo-Iranian and Shell Oil Company. Anglo-Saxon Oil is one of the Shell group.

Interest is chiefly centered on the first deep test boring being drilled at Ihuo, 70 miles north of Port of Harcourt in the Niger Delta.

W. E. EADIE, assistant managing director, and COL. HUGH B. SPENS, both members of the board of directors of the Burmah Oil Company, recently visited in Burma.

They toured the Chauk oilfield and Pagan. In Rangoon the two officials interviewed Prime Minister Thakin Nu.

ALBERT L. NICKERSON, for the past five years director of Socony-Vacuum Oil Company, Inc., in charge of domestic marketing, has been appointed vice president and will be the director in charge of foreign operations. Nickerson succeeds WALTER L. FAUST, who retired as a director and vice president at the end of 1951 on the advice of his physician.

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ROBERT H. CAIN, V. C., is the new general manager of Shell Company of West Africa, Ltd. Cain joined the Shell group in 1928, and in January, 1946, went to Malaya to assist the British military in clearing up Malaya after Japanese occupation.

TOM WARDEN, formerly with Iraq Petroleum Corporation, has accepted a position as tool pusher with Mene Grande Oil Company, C. A., in Eastern Venezuela.

T. C. Barger

W. R. Cooper

E. C. Austin

T. V. Stapleton

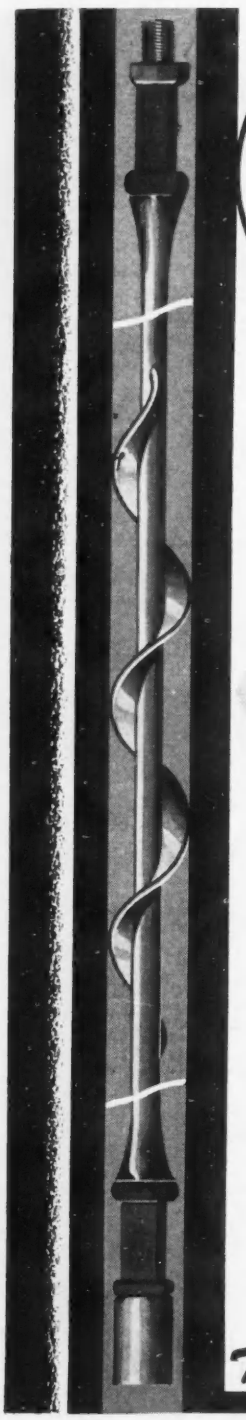
Arabian American Oil Company has announced appointments to six newly created positions as general managers in the company's operations in Saudi Arabia. T. C. BARGER, a geologist who has been with Aramco since 1937 and a specialist in government relations work since 1941, was named general manager for concession affairs. W. R. COOPER, who joined Aramco in 1944 as superintendent of engineering, was appointed general manager of the construction, maintenance and transportation department. Prior to joining Arabian American, Cooper was with The Texas Company since 1928.

E. C. AUSTIN, who joined Aramco in 1939, was named general manager of materials, supply and community service. T. V. STAPLETON, who has been refinery manager since 1944, was appointed general manager of field management. Stapleton's oil career started in 1923 with The Texas Company. R. A. EEDS was named general manager of field operations department. Eeds, who has been with various subsidiaries of Standard Oil Company (N. J.) since 1933, joined Aramco in 1950 as assistant general manager in charge of oil operations. W. A. WEBER was named general manager of industrial relations. Prior to joining Aramco, Weber spent 19 years in personnel work with Standard Oil Company of California.

D. N. EZELL, who joined Aramco in 1950 after 12 years with Magnolia Petroleum Company, was appointed manager of the manufacturing and supply department, and S. C. HARPER was named assistant to the general manager of oil operations. Harper joined Aramco in 1944.

R. A. Eeds

Wallace A. Weber



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BOTH are important

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KONTOL DOES NOT

Require elaborate application procedures—it can be pumped, lubricated or dumped into the well, or applied in solid stick form.

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Kirkuk-Banias Line to Open

Oil flow from Iraq to the Mediterranean will be more than trebled in April when British-operated Iraq Petroleum Company opens its newly-laid 30-inch pipe line from Kirkuk, Iraq, to Banias, Syria. As a temporary measure, the 30-inch line will be fed from the 12- and 16-inch pipe lines originally laid to Haifa, Jordan, and which were closed by the Arab-Israeli war in 1948. There is no likelihood of the pipe lines to Haifa being used in the immediate future.

The new 500-mile line follows the alignment of IPC's 12- and 16-inch pipe lines to Tripoli, Lebanon, to a point approaching the Lebanese frontier, then veers north to Banias. Self-supporting pump station communities are situated along the right-of-way.

Concurrently, the 30-inch line will be continued on to Kirkuk. Although adequate pumping equipment will not be installed until probably early in 1953, IPC hopes to approach the 105-million-barrel capacity by the end of 1952.

Added to the approximately 60 million barrels now being carried by IPC's two lines to Tripoli, the new pipe line will increase the total of Iraqi oil pumped to the Mediterranean coast to nearly 165 million barrels, more than three times the output in 1951.

With proven oil reserves nearly as great as those of Saudi Arabia, IPC will experience little difficulty in sustaining production at the rate of capacity of the 30-inch pipe line.

With inauguration of the Banias pipe line, IPC will surmount one of its major handicaps. Kirkuk and Mosul oil fields are more than 500 miles from the Mediterranean and Persian Gulf, and transportation of crude has always been a problem. Pipe lines to Haifa and Tripoli were IPC's only outlets until the Arab-Israeli war closed the Haifa pipe line.

The new line will allow full production, a vital factor in the recently-ratified agreement between IPC and the Iraqi government. The agreement calls for expansion of crude output.

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- MOULDED RUBBER PACKINGS ELIMINATE the stuffing boxes.
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Germany Output Registers 22 Percent Gain in 1951

A 22 percent gain in German crude output for 1951 was indicated in a preliminary report of 884,700 barrels produced during December. This would bring the year's production to a record 9,588,000 barrels as compared with 7,849,000 in 1950.

Contributing heavily to the increase was the older Hanover and Celle oil area. The Hanover province produced 4,485,200 barrels as a result of extensions in the Steimke and Wesendorf pools and development in the new Suderbruch, Eldingen, Wathlingen and Eddesse-Nord fields.

Emsland's output went up from 3,540,300 barrels in 1950 to 4,220,900 barrels (preliminary figure) in 1951. Production from Georgsdorf and Emlichheim was curbed to maintain reservoir pressure, but Lingen extensions enabled this comparatively old area to yield 701,700 barrels.

Suderbruch was the leading producer in the Hanover area during December with 81,800 barrels. Next came Steimbke with 61,400, Wesendorf with 49,900, Nienhagen with 46,200, and Eldingen with 35,100. In the Emsland area, Georgsdorf was the leader with 89,600, followed by Emlichheim with 78,800, and Ruehlermoor with 77,500.

. . . reminds us of a chap comparing the curves of 2 Lovelies! . . . both risk trouble "getting 'em together"

how long will it work?

All curves are *not* alike. Some involve troubles, some don't!

Now when you want *pin-point accuracy* and *reliability* in radioactivity logging, that calls for "Simultaneous Radiation Logging"—*exclusive* with, and done only by Perforating Guns Atlas Corporation. PGAC—and only PGAC—records these 3 factors *simultaneously* . . .

(1) a *pure* NEUTRON/NEUTRON Curve—*absolutely unaffected* by Gamma Rays of any kind

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(3) an accurate Depth Indication—by a *positive* locator of pipe-collars or flush-joints.

Because all three of these PGAC records are simultaneously made by a single instrument, on a single trip in the hole, they are *automatically correlated*. No correlation risks here!

All competitive logging methods for similar data require two or more trips in the hole . . . and then correlation of the separate curves—with the ever-present risk of human error. Bringing these curves together is even more hazardous than comparing the curves of a blonde and a brunette!

Moreover, PGAC—and only PGAC—uses the *pure* Brons NEUTRON/NEUTRON method of detection for the neutron curve. A *SLOW*-neutron counter is used to detect *SLOW*-neutron radiation only (resulting after fast-neutrons from the bombardment source traverse the formation being logged). And because this counter is *absolutely unaffected* by ever-present and detrimental gamma rays, the PGAC neutron curve is a *true* curve.

All competitive neutron curves could be termed "synthetic" because they are influenced by the detrimental gamma rays unavoidably detected under the Neutron/GAMMA method—upon which they are *solely* dependent. Consequently, such curves often lack clear definition . . . and their interpretations may innocently reflect conditions inconsistent with the true formation facts.

That's why PGAC's Simultaneous Radiation Log stands quite alone in giving you consistently *clearer definition*, greater *reliability*, pinpoint *accuracy*. For additional information on these subjects, send us your questions—and ask for our new catalog.

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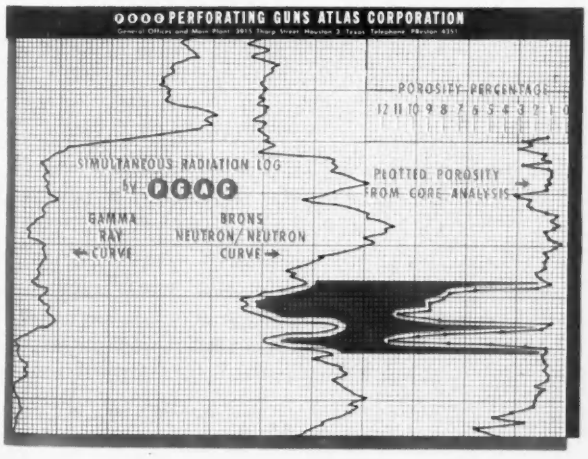
PROOF—on West Texas Reef Well

This section of a PGAC Simultaneous Radiation Log *again proves* the close relationship between the PGAC Brons Neutron/Neutron Curve and the plotted porosity of core analyses by a major oil company.



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Bermudez Sees Mexico As No. 1 Customer of U. S.

Mexico expects to become No. 1 customer of the U. S., declared Senator Antonio J. Bermudez, director general of Petroleos Mexicanos, the Mexican government petroleum administration, at a Dallas luncheon given in his honor last month by J. B. O'Connor, executive vice president of Dresser Industries, "Mexico wants to play a more important part in the production of oil in the Western Hemisphere," he emphasized.

"The United States and Mexico," he said in the address urging increased allocations, "should set an example before the world of how two countries should get along and cooperate with each other."

Senator Bermudez said if he failed to win the friendship of those engaged in the oil industry outside Mexico he would not consider himself fully successful in his post. Proud of Mexico's industrialization, he pointed to his nation's $700 million trade with the U. S. in 1951, making it the No. 1 U. S. customer in Latin America and No. 3 customer in the world.

"Oil is oil," he continued, "Whether it is produced under the laws of Mexico, of the United States, Venezuela, or Canada. To carry out th development of our oil and gas i dustry, we must be permitted to buy the necessary equipment and materials from you. We are most grateful to the Hon. Oscar Chapman (secretary of interior) and Bruce Brown (deputy petroleum administrator) for their visit to Mexico, and for the help they have given to us in this critical period.

"But, if we are to play that more important role, and progress along the lines of our national ambitions, we will need an increased allocation. We are hoping for that increase with a great deal of confidence."

Describing how Mexico's domestic oil consumption rose from 80,000 barrels daily in 1946 to 150,000 barrels today, Senator Bermudez said that last year 59 percent of Mexico's wells had been drilled by Pemex, and 41 percent by outside contractors, primarily from the U. S.

"I am sure," he commented, "that there are among those present today ready witnesses who will attest to the fairness of our conditions and the compensation paid for the effort and risk involved."

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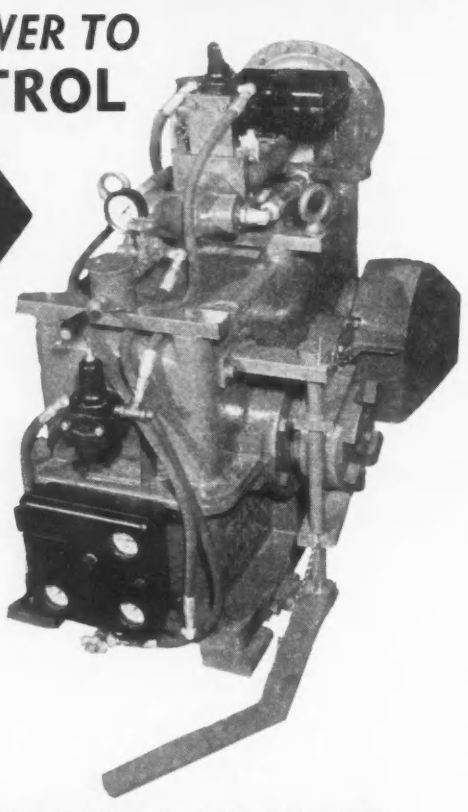

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Southeastern Oil Affiliate May Soon Drill in Mexico

Negotiations with Petroleos Mexicanos for a drilling contract begun about three years ago by Perfodora Southeastern, S.A., affiliate of Southeastern Oil, Inc., are "quite promising," according to Sigurd Scholle, the company's New York representative.

Soon to be drilled is an offshore well under the agreement whereby Cities Service Oil Company has been advancing money to Pemex for exploratory drilling "for several years," according to Cities Service. Location is in Tamiahua Lagoon off Tampico, about a mile north of El Toro Island and about six miles east of Shell's Dos Bocas well which produced 150,000 barrels in 1908 before it blew out and burned. Lasso Pros., independent contractor, will drill the well.

Activity in Alsace

Geophysical investigation in Alsace is being made by Pechelbronn Societe Anonyme d'Exploitations Minieres of Merkviller-Pechelbronn, crude producing firm of France, in conjunction with the French Office of Crude Oil Research.

Aramco to Continue Rapid Drilling Program

Arabian American Oil Company, which marked its most successful drilling campaign in Saudi Arabia last year with the completion of 32 wells and the largest annual extension to date in known estimated proven acreage, plans to continue operations at an accelerated pace throughout 1952.

Six of the nine rigs in continuous operation at the end of 1951 were on exploratory wells and the remainder on development drilling. Drilling during 1951 for a record footage of 215,779 feet led to 31 new producers, 1 observation well, 2 oil fields, and an increase of 114,200 proven acres. The previous peak year in drilling was 1948, when 24 wells were completed. Twenty-one were drilled in 1950.

Saudi Arabia's most important discovery of 1951 was 'Uthmaniyah field, brought in during April. About 40 miles south of Ain Dar field, a 1948 discovery, and 20 miles west of Hofuf town, this field has not yet been produced due to lack of a pipe line outlet connecting with a line now extending from Abqaiq field to the Persian Gulf. A 30- and 31-inch line to connect this field is scheduled.

Seven producing wells out of as many efforts were completed at 'Uthmaniyah in 1951, and the estimated proven acreage is 45,300 acres. The crude is 34 gravity found in the Arab lime of Jurassic age at a depth of 6863 feet. Thickness of the pay zone averages 261 feet.

Safaniyah, second 1951 Saudi Arabian discovery, brought in during May, had four producing wells at the year's end out of four attempts. This field produces 27 gravity crude from the Bahrein sand of Cretaceous age, with an average thickness of pay zone of 435 feet.

Largest development drilling occurred in the Ain Dar field, where 18 wells were completed in 1951, increasing the estimated proven area by 36,000 acres to a total of 81,800 acres. Ain Dar was placed on production last year with completion of a 29-mile 20-, 22-, and 24-inch pipe line with a capacity of 350,000 barrels a day to Abqaiq at the end of 1951.

Estimated proven area of the Haradh field in 1951 was increased by 13,300 acres to 41,400 acres.

Saudi Arabia's crude production during 1951, which reached a new high of 277,962,605 barrels, or a daily average of 761,541 barrels, came from 118 wells, an increase of 23 over the number of producers in 1950. At the end of the year, there were 62 producing wells in the Abqaiq field, the country's largest and one which accounts for two-thirds of the total output; 20 producers at Ain Dar; 30, including two gas wells, at Dammam; and 6 at Qatif.

At the end of 1951, Abu Hadriya, Fadhilo and Haradh fields, in addition to the two 1951 discoveries, were closed in due to lack of pipe line outlets.

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TRIPS NEW BIT	140.05	15.39
TRIPS NEW CORE BIT	31.63	3.48
RIG REPAIR	27.55	3.03
CIRCULATING OUT SAMPLES	22.33	2.45
CONDITION HOLE	65.22	7.17
REAMING	6.30	.69
DRILL STEM TEST	None	None
SET PIPE	None	None
WAITING ON ORDERS	3.85	.42
FISHING	5.62	.62
STRAIGHT HOLE TEST	None	None
ELECTRIC LOG	16.23	1.78
MOVING BARGE	31.00	3.41
TOTALS	910.00	100.00

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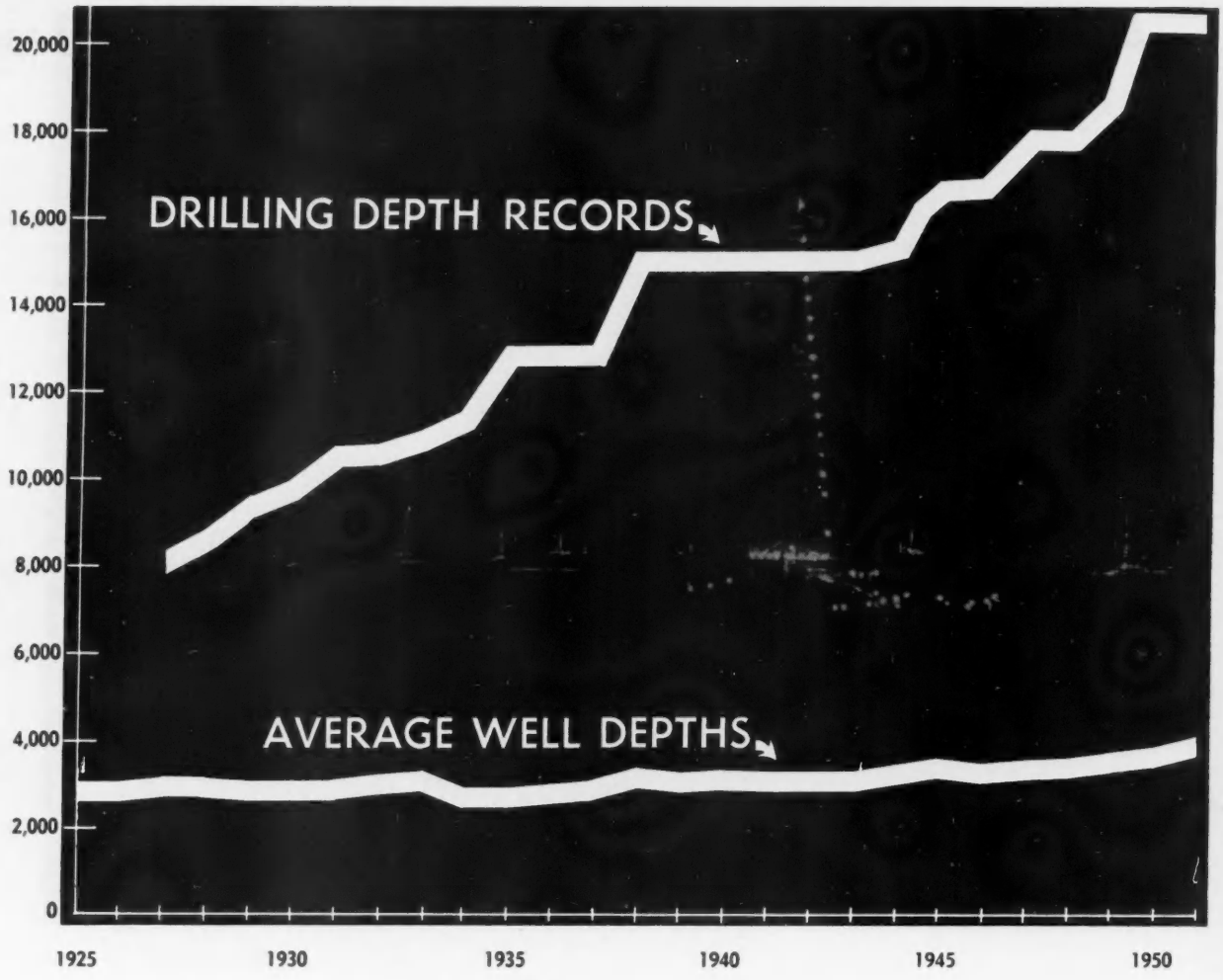

Equipment Meets Challenge of Deep Drilling

By J. E. KASTROP
WORLD OIL Staff

BEHIND the almost unbelievable record of the oil industry in 1951 is a fascinating story of progress. It is a story of incentive, faith, perseverance, and a never-ending drive to build the tools before they are needed. It is the story of those who must keep far ahead of today's requirements for machines and materials that perform the task of keeping this nation supplied with an ever-increasing volume of petroleum.

The spearhead of unparallel progress in oil is made up of a mighty drilling arm. Year after year, it has been the unceasing efforts of the drill that have made current production records possible. Oil has become more difficult to find, and in this elusive game of hide and seek, has forced men to look for newer horizons deeper and deeper in the earth. Sources of petroleum below 10,000 feet in the U. S. are enormous, and contribute substantially to unprecedented demand. Prior to 1930, these huge reservoirs were out of reach. But, thanks to those who design and make drilling equipment, wells now can be drilled to more than twice this depth and possibly to 25,000 feet. Metallurgy holds the key to even deeper drilling.

HERE IS a brief review of the seldom-told story about the major role that equipment progress has played in man's quest for petroleum from deeper and deeper horizons. Highlights of the persistent drive to produce equipment well in advance of its need are presented.

Early Progress Slow

Colonel Drake's historic well at Titusville, Penn., in 1859 reached a depth of less than 70 feet. The depth record today is held by the Superior Oil Company, which in 1949 drilled a Wyoming well to 20,521 feet. This tremendous increase in drilling depth in a period less than a century can well be the yardstick which measures the progress made in driling equipment and technology. However, it must be pointed out that most of this progress was made in the past half century after the introduction of the rotary method of drilling. Prior to 1900, the cable tool method of drilling predominated, and depths were limited to the strength of lines used at that time. Wells seldom exceeded 2000 feet. Today, cable tool depth records go below 10,000 feet.

After Rotary Time

Although the rotary method of drilling oil wells was introduced prior to 1901, it was unquestionably the boom at Spindletop and its unique drilling problems that brought the rotary method into popularity. Since

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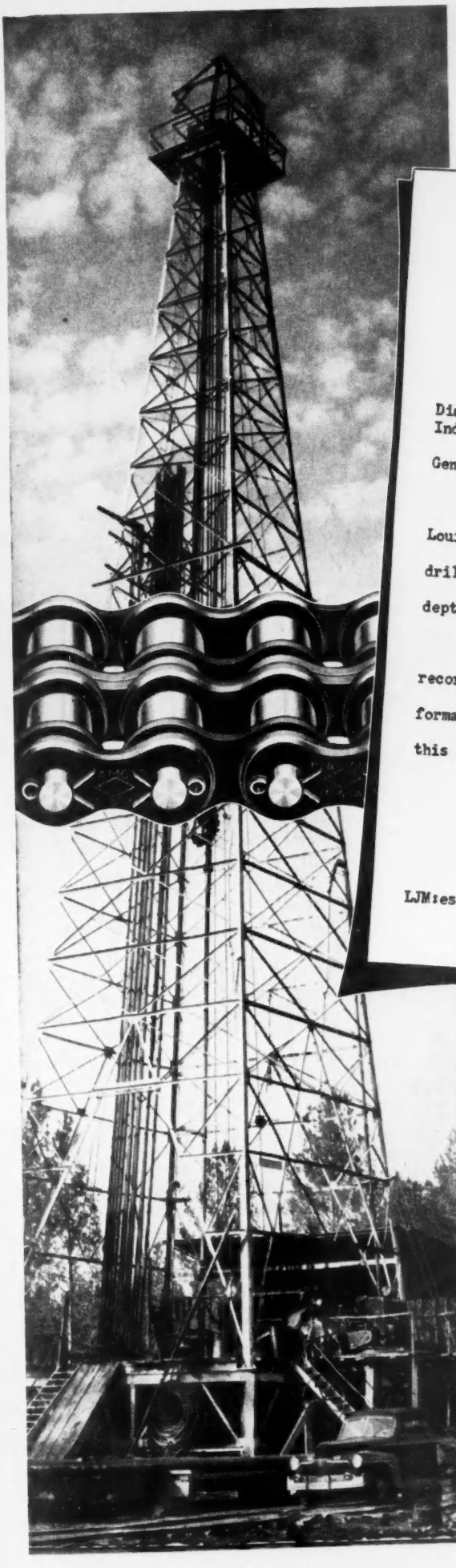

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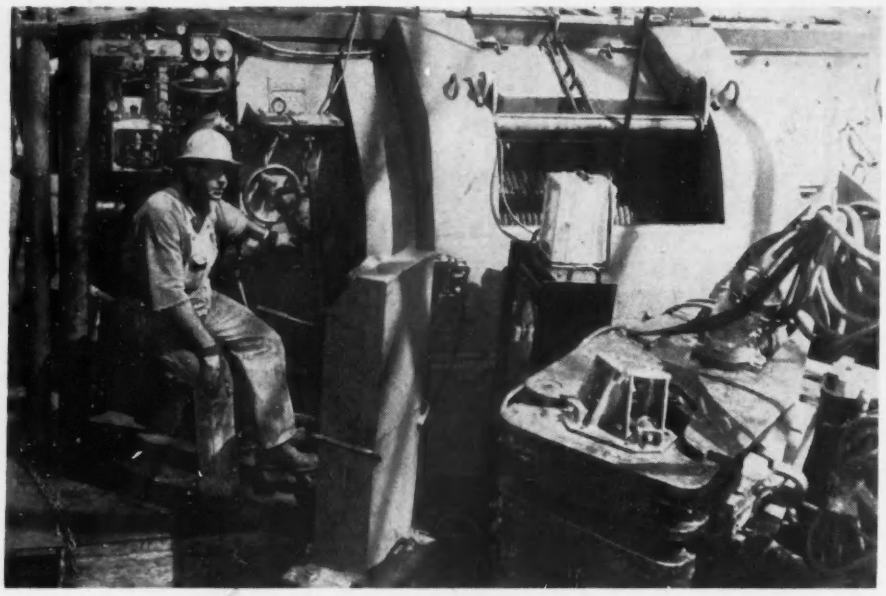
Refer to the classified section of your local telephone directory under the heading CHAINS or CHAINS-ROLLER

DIAMOND ROLLER CHAINS



Modern drilling is becoming more and more an automatic operation. This complicated equipment assembly represents field tests of new devices designed to take over some of the laborious jobs normally performed by crewmen.

that date, unbelievable progress has been made in rotary drilling equipment. Early engines, rated at only 15 horsepower, weighed about 3300 pounds. Heavy-duty modern engines develop as much as 1500 hp and weigh up to 32,000 pounds. Pointing out the progress of rotary drilling, John J. Conry, former president of The Carter Oil Company, in 1941 lauded ". . . the striking contributions of the scientist and the engineer to remarkable improvements in drilling equipment and methods."

Early derricks, made of timber throughout, measured only 60 feet. Steel structures used today tower up to 186 feet. As the bit penetrated deeper, more weight had to be supported, stresses and strains had to be accurately computed, and derricks had to be properly designed. While early drilling equipment was crude, it represented a substantial improvement over the first rotary. Manufacturers in other industries joined in the design and fabrication of engines, drawworks, rotary tables, pumps, etc. Many of the improvements came from the maker and the user, cooperating in a joint effort. Thus, in the very beginning, the maker and the user joined hands to cope with each new problem. As manufacturers became more specialized they were soon looked to for better tools and materials. This mighty segment of the industry . . . the manufacturers, suppliers, distributors, and service companies . . . accepted the challenge and added their own engineering staff. Today, this essential group is highly specialized in its particular field, each with its trained technologists and they have concentrated their efforts toward better equipment. This development grew from the continued demands for more oil and gas. More wells had to be drilled deeper and deeper. Associated problems became more complicated and involved more scientific fields, among which are metallurgy, electronics, hydraulics, and chemistry. The industry at large was setting such a pace that problems had to be anticipated well in advance. It has been largely due to this group of technologists that equipment and methods are available today which enable the industry to produce record-breaking quantities of petroleum.

Had the manufacturers of drilling equipment discontinued improvements with the rig of Spindletop days, the 20,000-foot well would be only a dream today. The average depth of wells drilled from 1859 to 1928 ranged from 30 feet down to 8525 feet, the average having been 1669 feet. With modern drilling equipment, the average well of that period could now be drilled in less than a day. It was not until 1927 that the average depth of oil wells attained 3000 feet. Since 1938, annual depth averages have exceeded 3000 feet and now approach 4000 feet. Table 1 shows the average well depths by years for the U. S.

TABLE 1

Drilling Progress in the U. S.

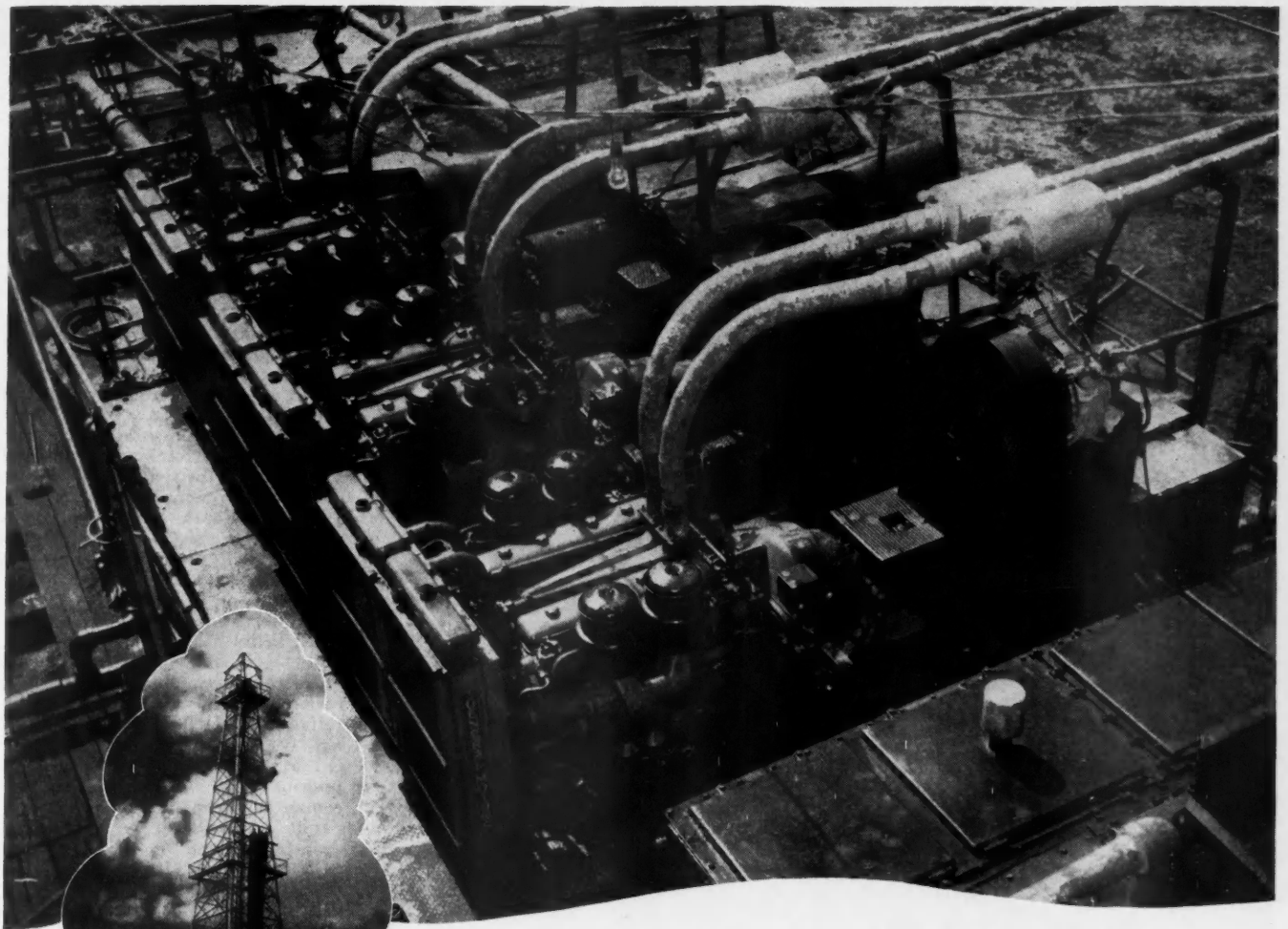
YEAR	Depth Record (Feet)	Average Well Depth (Feet)
1859–1928	.....	1669
1925	.....	2900
1926	.....	2800
1927	8,046	3000
1928	8,523	3000
1929	9,280	2895
1930	9,753	2900
1931	10,585	2924
1932	10,944	3011
1933	10,944	3032
1934	11,377	2731
1935	12,786	2829
1936	12,786	2861
1937	12,786	2974
1938	15,004	3144
1939	15,004	3053
1940	15,004	3088
1941	15,004	3056
1942	15,004	3088
1943	15,004	3046
1944	15,279	3272
1944	16,246	....
1945	16,655	3489
1946	16,668	3345
1947	17,823	3404
1948	17,823	3463
1949	18,734	3558
1949	20,521	....
1950	20,521	3689
1951	20,521	3888

Record Depths

It was not until 1931 that a well went below 10,000 feet. However, in only 18 years this depth was doubled. Table 1 also contains the depth records by years, and is truly a progress curve of drilling equipment. Each new invention introduced as the oil industry grew in stature added to the efficiency and capabilities of the drilling rig. Blowout preventers in 1906 brought to a close the days of gushers. Introduction of rock bits at about the same time reduced footage costs through consolidated formations. Higher rotation speeds and heavier loads brought on new problems and resulted in more efficient equipment. Tool joints were brought out in about 1910, and have been continually improved since. Casing was not strong enough for deeper wells and the beginning of better casing commenced in the early 1920's with seamless casing and has continued to improve in quality ever since.

As the drill went deeper, equipment necessary to handle the enormous loads had to be made larger and heavier. The physical limitations of man in handling this heavy machinery were being approached. A new technology entered the picture. Automatic controls for performing the laborious tasks were introduced. Pneumatic, hydraulic and electronic devices have enabled man to control nearly every operation in drilling wells. Improvements continued in this field and at this time it is not too fantastic to talk about a rig that is almost automatic in every feature.

The geophysicist knows that structures favorable for the accumulation of petroleum are found in many areas below 25,000 feet. Geologists believe that hydrocarbons can exist at these depths. The almost miraculous accomplishments in drilling equipment design and construction indicate there will be no physical limitations as far as tools are concerned in drilling a 25,000-foot well. It is merely a question of economics. When the industry needs equipment to go deeper, past records indicate that the designer and manufacturer will supply it.



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"These engines were placed in operation in July, 1950, and to date have drilled many thousands of feet of hole. These engines have been very satisfactory and we think Stewart & Stevenson perform a good service for the oil industry and one that is vitally needed. You have our permission to use our name and quote us on a job well done."

Yes, Al Buchanan Drilling Company is another of the industry's leading drilling contractors who have given their endorsement to GM Diesel Engines and Stewart & Stevenson Services. Let us tell you the full story of GM Diesel Engine dependability, economy and flexibility. Call your nearest Stewart & Stevenson representative today. No cost or obligation.

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MEN IN THE INDUSTRY NEWS

Transfers and Promotions

In Magnolia Petroleum Company's Producing division, **John S. Russell**, Falfurrias district production foreman, has been promoted to Falfurrias assistant district superintendent. **Charles W. Hickok** has been transferred from Magnolia's Panhandle district to the Electra district as petroleum engineer. **Charles L. Barney, Ralph D. Burks, Ernest R. Frazier** and **James E. Leonard** have been transferred from the company's Kermit Producing district to the new Pegasus district as petroleum engineers. Also transferred were **A. W. Shaw, Jr.** and **Clarence Wells, Jr.** as petroleum engineering assistants. **Lawrence M. Green,** assistant foreman in the Falfurrias Producing district, has been promoted to production foreman at the Vanderbilt district. **Charles A. Miller,** petroleum engineering assistant in the Kermit district, has been promoted to assistant foreman in Magnolia's new Pegasus district near Midland, Texas. In Magnolia's Geological department, Exploration division, **H. A. Sellin** has been named regional exploration geologist in Dallas. He replaces **C. Ivan Alexander,** who has been made supervisor of the exploration research division at Dallas. **W. Lloyd Haseltine** has been transferred from district geologist at Wichita Falls, Texas, to the same position in Mt. Vernon, Illinois. **John C. Freeman** has been promoted to district geologist at Wichita Falls. **O. F. Beaty** has been transferred from landman at Amarillo to Mt. Vernon, Ill., in Magnolia's Land department. **Fred A. Dulaney, Jr.,** has succeeded Beaty as district landman in Amarillo. **Basil Moss** has been transferred to New Orleans, where a new Land department district has been opened.

In the production department technical staff of The Carter Oil Company, **W. S. Stovall** assumes direction of the petroleum engineering section in the Tulsa office and **W. C. Butler** becomes district engineer at Great Bend. **S. G. Branyan,** goes to Seminole, Okla., as district engineer and **Howard C. Kauffman,** Vicksburg, Miss., moves to Magnolia, Ark., as district engineer. **H. H. Goerner,** petroleum engineer at Magnolia, will be district engineer at Vicksburg. **R. B. Chapman,** assistant division engineer of Carter's central division at Oklahoma City, becomes acting division engineer and **H. E. Allen,** Wilson, moves to Oklahoma City as acting assistant division engineer. **J. L. Barthel** is the new acting district engineer of Wilson district. **J. S. Bottler** has been transferred to Shreveport as a member of Carter's Southern division engineering staff.

•

Joseph D. Harnett has been named assistant manager of the Transportation department of The Standard Oil Company (Ohio).

Harnett joined Sohio in 1941 as an engineer in the Transportation department. He is a 1939 graduate of Purdue University. Prior to his Sohio employment, he worked as an engineer with Consolidated Edison Company of New York and Worthington Pump and Machinery Corporation. In 1944, Harnett was assigned to St. Louis as assistant chief engineer, Sohio Pipe Line Company. In 1947, he became general superintendent of pipeline operations and, in 1950, he was assigned additional responsibilities. Harnett has also held posts as vice president and director of Sohio Pipe Line Company.

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Model LF-190, 157 inch wheelbase, 30,000 lbs. GVW.

William C. Whaley, Los Angeles, a vice president and director of Sunray Oil Corporation, has been transferred to the company's general offices in Tulsa, where he will become a member of Sunray's executive committee and chairman of the company's operating committee.

R. E. Foss, Los Angeles, vice president for Sunray's West Coast division, of which Whaley was formerly manager, has been named vice president and manager of the company's operations there.

Whaley is giving up the chairmanship of the company's operating committee, now to be headed by Whaley, and **Paul E. Taliaferro**, Sunray director and vice president, will be vice chairman of the group.

Whaley joined the former Barnsdall Oil Company in 1924, became a vice president of that organization in 1931 and was made general manager of that company's California operations in 1941. He joined Sunray in June, 1950, as a director and vice president when Barnsdall was merged into Sunray Oil Corporation.

Foss, who will be manager of Sunray's West Coast operations, is a graduate of the California Institute of Technology, joined the former Barnsdall organization in 1935 as petroleum engineer and has been successively production foreman, drilling engineer, and vice president.

Leslie H. True has been elected president of Magnolia Pipe Line Company, succeeding **J. L. Latimer** who has been elevated to chairman of the board. **Don R. Ford**, assistant manager of pipe lines and board member, was elected vice president, and **A. T. Glover**, general superintendent, was made a member of the board of directors.

L. H. True

True, who has been with the Magnolia organization for nearly 30 years, has served as pipeliner, time keeper, gauger, pipe line scout, and as a district superintendent before being transferred to Magnolia's general offices in Dallas 15 years ago. True was made a vice president in October, 1945, and on January 1, 1946, was made manager of pipe lines.

A. T. Glover

D. R. Ford

Ford has been with Magnolia Pipe Line Company for nearly 25 years, during which time he has been pipeliner, district gauger, chief gauger and has held various supervisory positions in many areas. In August, 1949, he was transferred to Dallas to be assistant manager of pipe lines from division superintendent of the company's southern division at Houston. Ford was made a member of Magnolia Pipe Line Company's board of directors a year ago.

Glover has been general superintendent for ten years. During his early service he assisted in the construction of some of the first pump stations of Magnolia's pipe line system. After serving as construction foreman at various places in Texas he was moved to Oklahoma where he later became district superintendent at Wewoka and then superintendent of the Oklahoma division with headquarters at Oklahoma City. Glover was transferred to the company's general offices in Dallas in 1942 and promoted to general superintendent.

•

Vaughn Maley and **W. E. Dougherty**, division geologists for Humble Oil & Refining Company's West and Southwest Texas divisions, have exchanged posts.

Haley, a 1926 graduate of the University of Texas, went to work for Humble in Midland in 1927, and was made division geologist in 1941. His move to Corpus Christi is a return to his native county.

Dougherty, a University of Texas graduate in 1936, also joined Humble in Midland. After serving in the army, he became division geologist at Corpus Christi in 1948.

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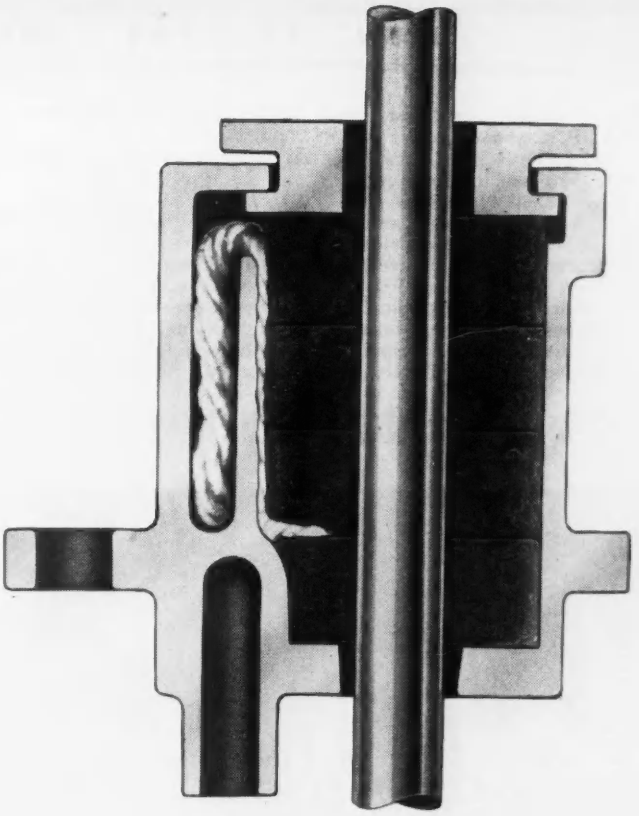

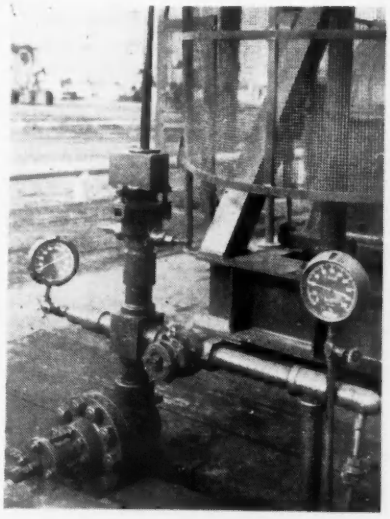

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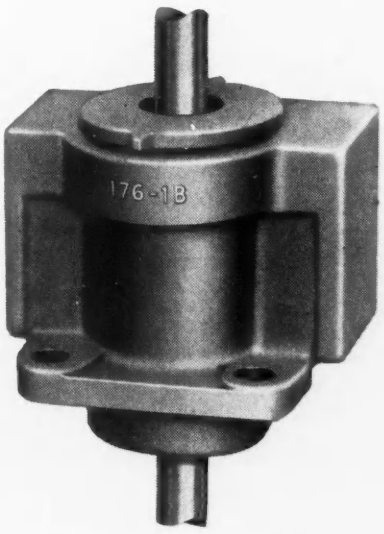

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The oiling system in the No. 176-1B Lubricating Cap is by means of felt rings which are constantly supplied with oil through a wick from the oil reservoir within the cap . . . see sectional view above. When installing, the operator should completely saturate the felt rings in 1 pint of oil; place the wick in the oil reservoir and then between the felts and the wall of the chamber as shown; and then fill the reservoir with an additional pint of oil. Periodic inspection by the pumper or utility man to see that a sufficient oil supply is maintained is all the service required to assure continual lubrication of the polished rod. The felt rings will last indefinitely unless subject to undue abuse.

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RATIGAN PRODUCTS ARE SOLD THROUGH LEADING SUPPLY STORES

Leslie Bowling, consulting geologist, announced that **A. P. Claudet**, former general manager and executive vice president of Schlumberger Surenco and Schlumberger of Latin America, has become a partner of Bowling and Claudet, with offices at 510 California Building, New Orleans.

Bowling, a graduate of the University of Texas, has been active since 1928 in the geological exploration and exploitation branch of the oil industry. He has been a past president of the Houston Geological Society and of the New Orleans Geological Society.

Claudet, a graduate of the Ecole Professional Diderot, Paris, France, was connected with the Schlumberger group for more than 22 years. He is a past president of the New Orleans Geological Society.

•

Charles R. Elder, St. Louis, has been promoted to superintendent of Sohio Petroleum Company's Southwestern division, and will be responsible for all Sohio's transportation development ond operations in Oklahoma, Kansas, Texas, Louisiana, Arkansas and Mississippi. Ellder has been conducting Southwestern operations since 1950 as assistant superintendent and will continue to make St. Louis his headquarters.

Fred C. Fellingham has been appointed division office manager for Stanolind Oil and Gas Company's Central division, with headquarters in the First National Building, Oklahoma City. Fellingham, former assistant administrative coordinator in the Tulsa office, replaces **Dan M. Reed**, who will hold a similar position in the North Texas-New Mexico division.

Fred C. Fellingham

Fellingham, a native of Chicago, joined the Dixie Oil Company following graduation from Dartmouth College in 1927. In 1931 he became a landman for Stanolind. He has also served as assistant manager of industrial relations and assistant administrative coordinator.

•

W. T. Kennedy, formerly assistant to the general superintendent of production at Findlay, Ohio, for The Ohio Oil Company, has been appointed assistant division superintendent in the Los Angeles division at Bakersfield, Calif.

R. E. McMillen, Houston division petroleum engineer, has been named assistant to the general superintendent of production, succeeding Kennedy.

L. H. Shearer, petroleum engineer in the Houston division, has been promoted to Houston division petroleum engineer.

J. H. Shonk, formerly assistant district superintendent at Robinson, Ill., has been appointed special assistant to the division superintendent of the Terre Haute division.

A. W. Stewart has been named supervisor of personnel in the Terre Haute division. He was formerly supervisor of personnel in the Shreveport division.

L. W. Pelton, landman at Shreveport, has been appointed supervisor of personnel in the Shreveport division, succeeding Stewart.

•

Charles A. Houston has been appointed district geologist in the Southeastern district exploration office of Stanolind Oil and Gas Company at Jackson, Miss. He replaces **B. F. Baldwin**, who has been transferred to Albuquerque, N. M., as district geologist of the Northwest New Mexico-Arizona district.

After attending Lehigh University at Bethlehem, Penn., for two years, Houston received his degree in petroleum engineering from the University of Oklahoma in 1942, and in 1947 received a degree in geological engineering from the University of Oklahoma. He joined Stanolind in 1942 as a roustabout in the Zenith area in Kansas. In 1947 Houston came to Jackson as a geological scout, and after successive promotions was named senior geologist in July, 1951, the position he held immediately before being named district geologist.

The southeastern district includes Illinois, Indiana, Kentucky, Tennessee, Mississippi, Alabama, Georgia, and Florida.

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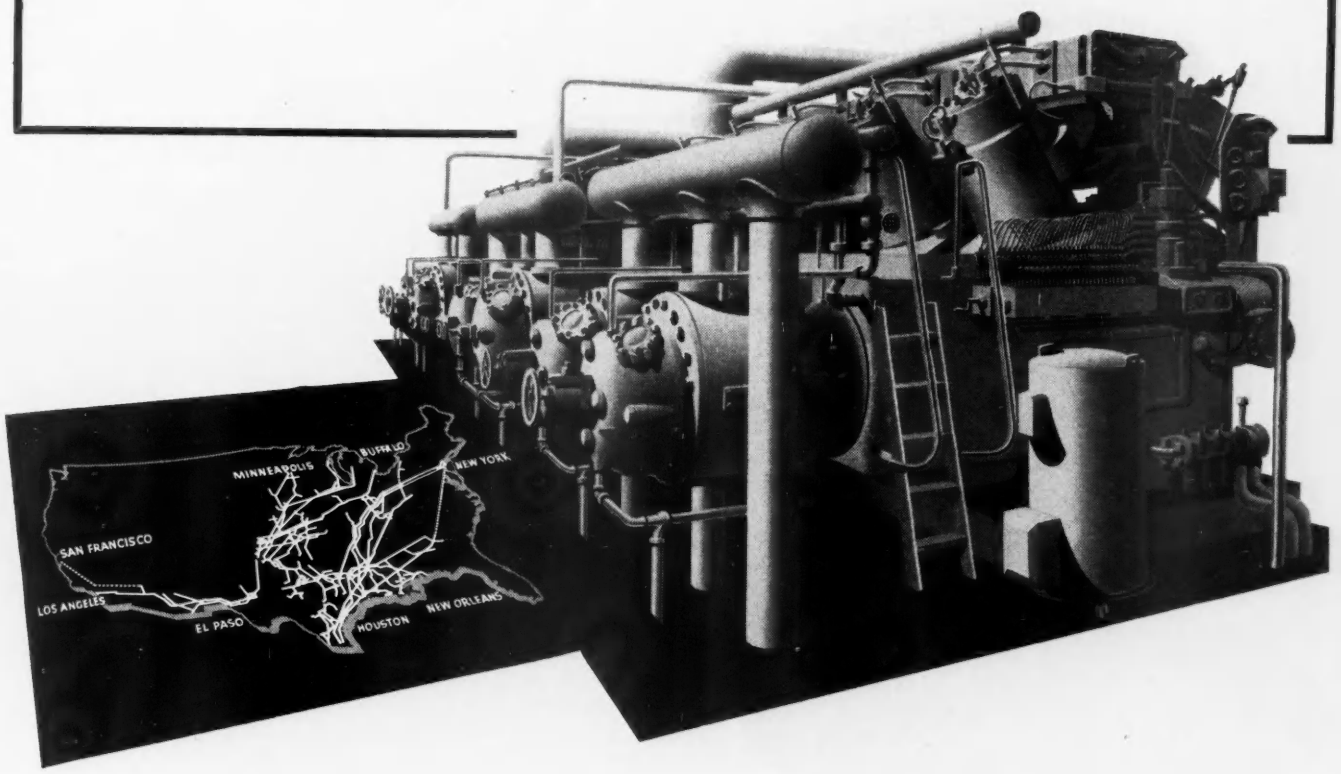
for pipe line compressor units,
helps prevent operating troubles



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GULF INDUSTRIAL LUBRICATION

J. H. Miracle, former secretary of the United Gas Corporation, was elected a vice president, and **B. H. Winham**, assistant to the president, was elected secretary.

Miracle has worked in the oil and gas business for more than 30 years, and has been in the United Gas organization since 1931. He was elected secretary of United's subsidiaries in 1937 and became secretary of the corporation in 1946.

Winham, assistant secretary of United Gas Pipe Line Company and Union Producing Company, joined the organization more than 20 years ago, and was named assistant to the president in 1947.

Raymond Chorney, district geologist and manager of the Rocky Mountain operations for Wilshire Oil Company, Inc., has resigned to open offices in Casper, Wyo. as consulting geologist. He will do exploration, appraisal and evaluation work.

•

Thom H. Green, research geologist for Sunray Oil Corporation, has been transferred to Tulsa as division geologist for Gulf Coast operations. Green joined Sunray in 1948 as district geologist for western Oklahoma. A graduate of the University of Colorado, Green did graduate work at the University of California.

Keep bottom water out of your wells—and prevent costly shutdowns—by tamping Eagle-Picher Lead Wool in the hole. A watertight plug that seals every crack and crevice is made by this finely stranded, flexible metallic wool. Shipped in convenient 50-lb. sacks . . . easy to spot in special cartridge-shaped Eagle-Picher Wire Containers sized to fit all casings. Order through your jobber.

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EAGLE EP PICHER

Joseph F. McCarthy has been appointed assistant division superintendent for the Southwest Texas division, Humble Pipe Line Company. **Francis W. Leary** and **William W. Brooks** have been named district superintendent and assistant district superintendent for the Alice district.

McCarthy began as a pipeliner at the Ingleside Station. In 1941 he aided in the construction of a line from Portland, Maine, to Montreal. During World War II, he was loaned to PAW as a pipe line consultant. Since 1944 he has served in several supervisory positions in the Southwest Texas division.

Leary, a graduate of Notre Dame University, started with Humble as a clerk in Sonora. He became assistant district superintendent in Alice in 1945 and acting district superintendent in 1951.

After attending New Mexico A. & M. College, Brooks went to work for Humble as an oiler at the Navasota Station. In 1951 he became acting assistant district superintendent in Alice.

•

H. B. Fuqua, chairman of the board and chief executive officer of Texas Pacific Coal and Oil Company, has been elected chairman of the board of The Fort Worth National Bank. Fuqua, a director of the bank since 1948, has been in the oil business since his graduation from the University of Oklahoma in 1919 with a degree in geology. He worked for Empire Gas and Fuel Company and The Atlantic Refining Company before joining Gulf Production Company in 1922. He had advanced to assistant to the vice president in charge of production operations for the Houston division when, in 1949, he resigned to join Texas Pacific.

H. B. Fuqua

•

Warren R. Deel, chief engineer at Service Pipe Line Company's Kadane pump station, has been promoted to division machinist with headquarters in Bowie, Texas.

In addition to a trunk line pump station, the company has an equipment repair building in Bowie. Deel, with **J. R. McClintock**, also a Service Pipe Line division machinist, will maintain the equipment in the Bowie district. **J. P. Bradley** is superintendent of the district.

J. M. Turner, district gauger, will be in charge of the semi-automatic Kadane station.

•

C. T. Alexander, who started with The Texas Company, has been promoted to assistant division manager of Louisiana division, Producing department. Alexander will be succeeded as division land and leaseman by **G. A. Gammill.**

Starting as leaseman in 1919, Alexander became division land leaseman at Shreveport in 1929, and was transferred to New Orleans in 1941.

Gammill was employed as a leaseman in 1928 at Shreveport. He served as assistant division land and leaseman at Lafayette in 1939 and at New Orleans in 1941.

It begins where other gauges leave off-

The now recognized ability of the Marsh Mastergauge to do a better job for more years is a direct result of setting out to design and build an instrument possessing accuracy, precision, and stamina beyond any gauge that had ever been produced.

Try the Mastergauge where other gauges have failed — under the gruelling conditions of extreme temperature, heavy pulsation, racking vibration — conditions that wreck the ordinary kind. You will find that it truly begins where others leave off.

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And remember: The toughest gauge to knock *out* of adjustment is the easiest gauge to get back *in* adjustment . . . thanks to the exclusive "Marsh Recalibrator."

Ask your supply store, or write us, for Marsh Oil Industry Bulletin.

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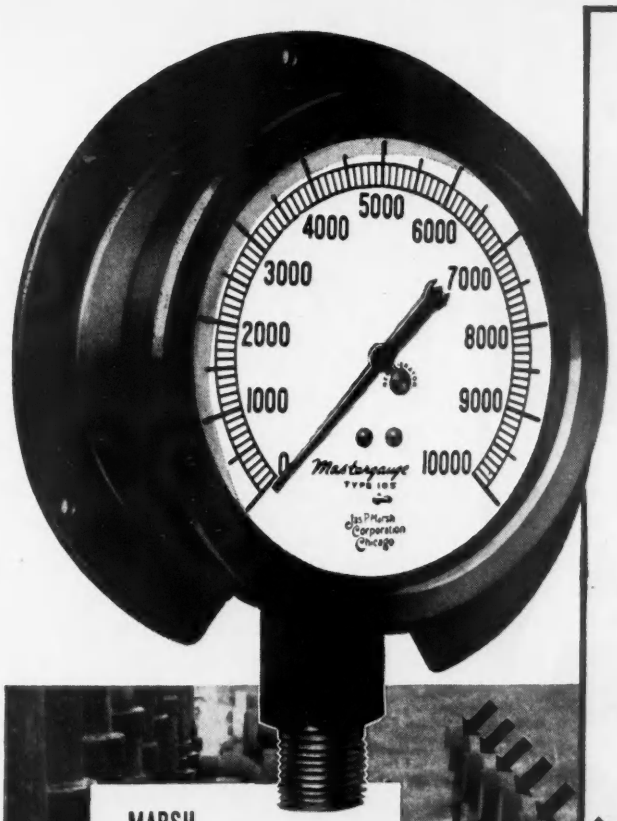
The Marsh branch plant at Houston offers shipment from stock and advanced facilities for repairing all makes of gauges.



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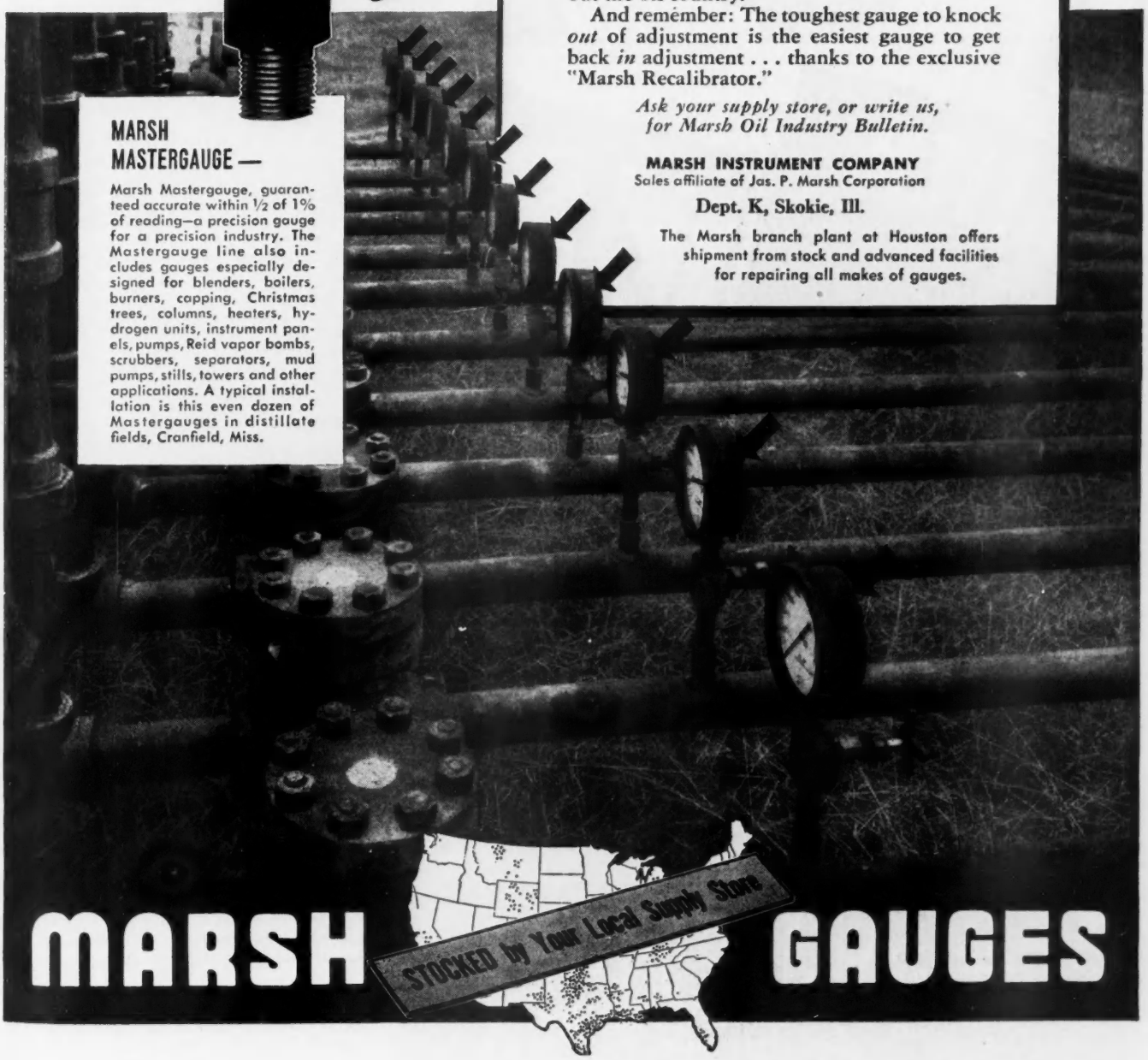
Marsh Mastergauge, guaranteed accurate within ½ of 1% of reading—a precision gauge for a precision industry. The Mastergauge line also includes gauges especially designed for blenders, boilers, burners, capping, Christmas trees, columns, heaters, hydrogen units, instrument panels, pumps, Reid vapor bombs, scrubbers, separators, mud pumps, stills, towers and other applications. A typical installation is this even dozen of Mastergauges in distillate fields, Cranfield, Miss.



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Double Reduction Gear Ratio 32.48:1
Structural Rating 14,000 lbs.
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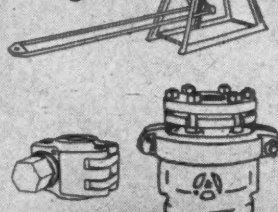

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MEN IN THE INDUSTRY NEWS

Charles A. Perlitz, Jr., vice president and director of Continental Oil Company, has relinquished his duties as general manager of the southern region to become a member of the executive headquarters staff in Houston. He will be in charge of transportation, crude oil trading, purchasing, and public relations activities, and will also serve as chairman of the financial advisory committee, and act as liaison with subsidiary and affiliated pipe line companies.

C. A. Perlitz, Jr.

Perlitz joined Continental as general attorney in 1946. Prior to that time he was with Fulbright, Crooker and Freeman, Houston, from 1929 to 1938, and with Strake Petroleum, Inc., Houston, for seven years.

Continental's southern region has been divided into two regions. Headquarters of the revised southern region remain in Houston, and headquarters of the new Southwestern region are in Fort Worth.

O. L. Fisher, assistant general manager of the present southern region, has been promoted to general manager of the revised southern region. **K. W. Brill,** manager of the exploration in Continental's Rocky Mountain region, has been promoted to assistant manager of the southern region.

H. H. Hinson, former assistant manager of the production department, will head the new southwestern region as regional manager, and **George W. Evans,** manager of transportation and purchasing, will be Hinson's assistant.

•

F. F. (Jack) Badger has been promoted to area landman for the San Antonio office of the Deep Rock Oil Corporation. He has been replaced as scout in the San Antonio office by **Robert A. G. Joseph.**

Badger attended St. Edward's University and the University of Houston, and had several years experience as a scout prior to joining Deep Rock in 1950. He was a captain in the Air Force during World War II.

Joseph is a native of Switzerland and was educated in that country and in England. He had worked in Mid-Continent fields before joining Deep Rock.

•

J. Durwood Pate, formerly with Republic Natural Gas Company, Oklahoma City, has joined Eason Oil Company as district geologist for Oklahoma. **Eugene F. Culp,** former instructor in geology at Oklahoma University, has been appointed junior geologist.

David B. Richardson, formerly with Richardson, Shartel and Cochran, has been named vice president in charge of the Land and Legal department.

•

A. L. Selig, consulting geologist, announced removal of his office to 1650 Bank of Commerce Building, Houston.

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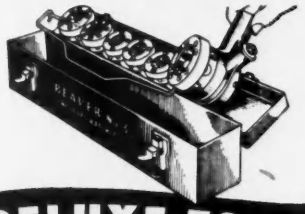

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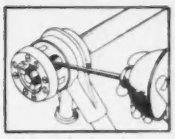
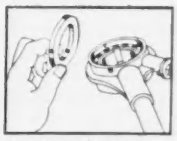
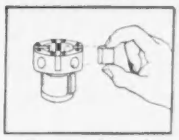
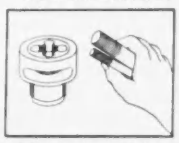
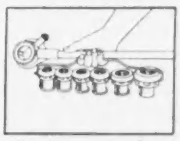

Oil and chip holes between dies.


Enclosed ratchet for safety.


Square shaped dies, no weak section.


Bolt dies available.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Men in the Industry NEWS

Ira H. Cram, Houston, has been elected a director of Continental Oil Company.

Cram, vice president in charge of exploration, joined the company in January, 1949, after having been with The Pure Oil Company more than 25 years. He is a past president of the American Association of Petroleum Geologists.

Ira H. Cram

Cram succeeds **W. H. Ferguson**, Denver, retired executive vice president of Continental, who resigned as a director but who will continue to serve the company in an advisory capacity. He has been a director nearly 30 years.

•

Henry N. Toler, chief geologist and manager of the Production department of Southern Natural Gas Company, has resigned to open offices as a consulting geologist in Jackson, Miss. Toler, a member of AAPG, was secretary-treasurer and a member of the Executive Committee of that organization during 1949 and 1950. He is also a member of the Gas Reserve Committee of the American Gas Association.

•

William L. Horner, petroleum engineer for Sunray Oil Corporation, is manager of a new department established by the company for the control of reservoir engineering and repressuring operations.

W. L. Horner

Horner will direct the department from the company's general offices in Tulsa, drawing from the company's present engineering staff for the nucleus of the department. The new department will work in close collaboration with both the production and natural gas sections of the company, but will assume responsibility for controlling reservoir engineering.

Horner has been with the company since 1943 and has done extensive work on unitization and pressure maintenance projects in principal oil producing states. Currently he is chairman of the engineering committee of the Scurry Area Canyon Reef Operating Committee now in the process of setting up a unitization agreement for fluid injection repressuring in the Kelley-Snyder and adjacent fields in Scurry County, Texas.

Horner has published more than 40 papers in American Petroleum Institute, API, AAPG and other journals. He holds professional degrees in petroleum and geological engineering from the University of Pittsburgh.

Herbert A. Hemphill, a geologist in West Texas for the past 22 years, has been appointed president of Texas Eastern Production Corporation, wholly-owned subsidiary of Texas Eastern Transmission Corporation. Hemphill resigned from Magnolia Petroleum Company at Midland, Texas, to accept the new post. His new headquarters are in Houston.

Hemphill studied geology at the University of Texas. In 1930 he was employed as a subsurface geologist for University Lands in West Texas with headquarters in San Angelo. After 4½ years he began work with Magnolia as an assistant geologist at Midland, later becoming district geologist there. As district geologist his area covered most of the Permian Basin that is in West Texas.

Hemphill succeeds **R. H. Hargrove**, who resigned as head of the producing company to devote his full time to administration of Texas Eastern Transmission Corporation, of which he is president and director. Hargrove continues as director of Texas Eastern Production Corporation.

•

Earl A. Brown has been elected vice president and a member of the board of directors of Magnolia Petroleum Company. He has been general counsel of Magnolia since last August.

Earl A. Brown

Brown was graduated from the University of Texas Law School in 1914 and after practicing law for three years in Ennis and Waxahachie, Texas, he moved to Tulsa, where he practiced until 1920. He later moved to Ardmore and became associated with a firm that represented Magnolia in southern Oklahoma. In 1936 he joined the company's legal staff at Oklahoma City and in 1939 was transferred to Magnolia's general offices in Dallas as assistant general counsel.

•

Dr. William A. Gorman has resigned as manager of Royal Oil & Gas Corporation to become vice president of Rycade Oil Corporation, Houston, Dr. Gorman received his B.A. and Ph.D. degree from the Geology department of the University of Minnesota.

•

J. C. Brooks has been promoted to assistant to general manager of The Texas Company's Producing department and is succeeded as department agent, Accounting division of the Producing department, by **E. M. Jacobs**, formerly assistant department agent.

Louis W. Anderson, departmental chief accountant, steps up to assistant departmental agent. **Alfred R. Kroulik**, assistant to departmental agent, becomes departmental chief accountant.

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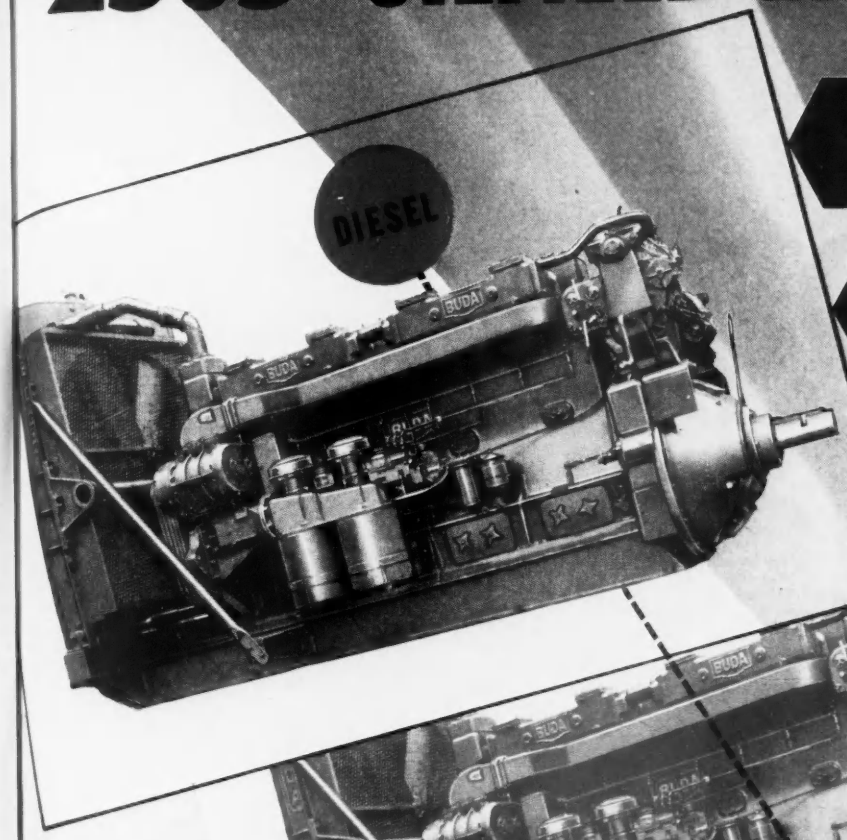
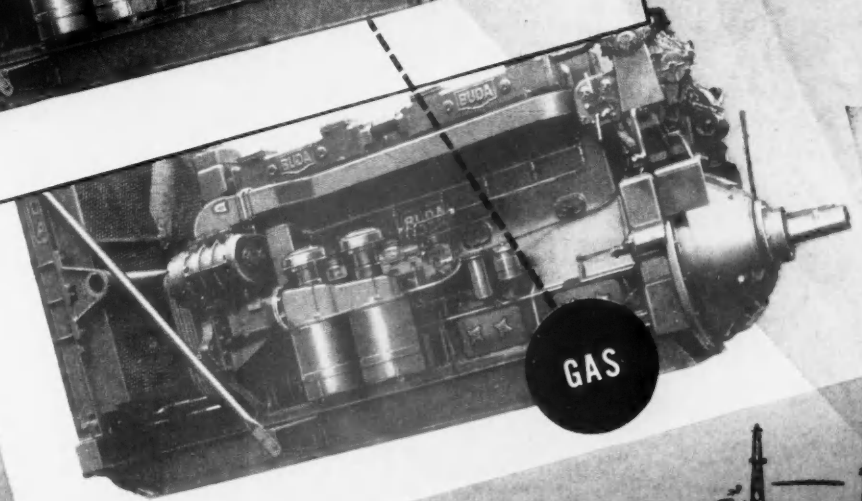
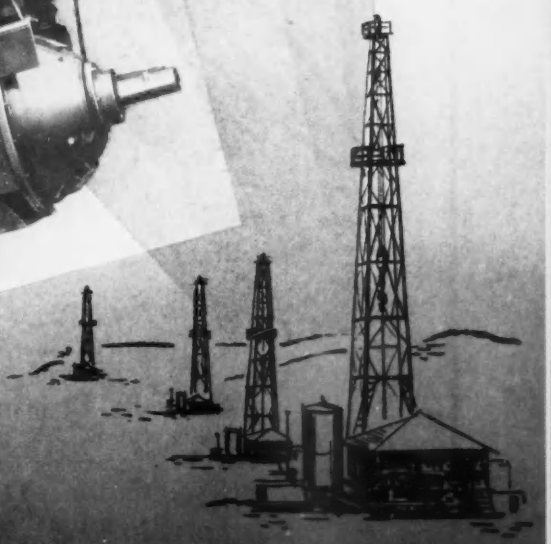
POWER . . .

ACCELERATION—

and DOUBLE PROTECTION







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DEATHS

Adolph Leonard Weil, 76, former president of General Petroleum Corporation, Los Angeles, died February 25.

A. L. Weil

Weil became connected with the oil industry almost immediately after receiving his law degree from the University of California in 1899. His practice included problems relating to land, legislation and taxation for several oil industry clients.

In 1910 he handled the incorporation of the Esperanza Consolidated Oil Company which later became General Petroleum. He served as general counsel for both organizations until he retired in 1940. From 1934 to 1940 he also served as president of General Petroleum.

Weil was one of the organizers of the Kettleman North Dome Association, the first important oil field unitization effort. He was a former governor of the San Francisco Bar Association, former president of the California Oil & Gas Association, and a panel member of the War Labor Board.

Since his retirement as president of General Petroleum, Weil had been engaged in private law practice in Los Angeles.

•

Norman L. Dorn, vice president of Lane-Wells Company, died at his home in Long Beach, Calif., March 2.

A native of Cleveland, Ohio, Dorn spent most of his life in Nevada and California. He had been connected with the petroleum industry for more than 30 years. Before joining Lane-Wells in 1937, he was with Shell Oil Company for 18 years in a progression of positions leading to superintendent of production in the Southern division at Long Beach.

In addition to serving Lane-Wells as vice president, Dorn directed the company's engineering activities from 1937 until February of this year, when he relinquished his title of chief engineer to become vice president and consultant.

Dorn was active in most of the affairs of the industry and held memberships in the API, AIME, Nomads, and Petroleum Production Pioneers. He was also a member of the California Club of Los Angeles, and University Club of Long Beach, and the Virginia Country Club.

A graduate of the University of Nevada, Dorn served overseas with the 38th Engineers in World War I.

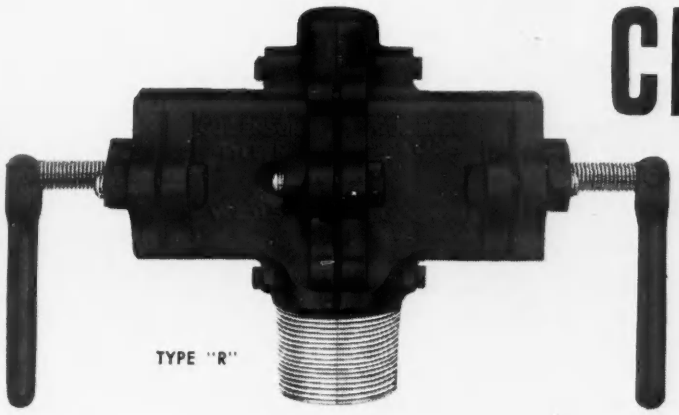
•

J. L. Stebbins, 58, independent oil operator, died March 13 in Jackson, Miss. He was formerly associated with the Gladys Bell Oil Company in Oklahoma and later became an independent operating in Tulsa, Okmulgee, Okla., and Evanston, Ill. He moved to Jackson 12 years ago.

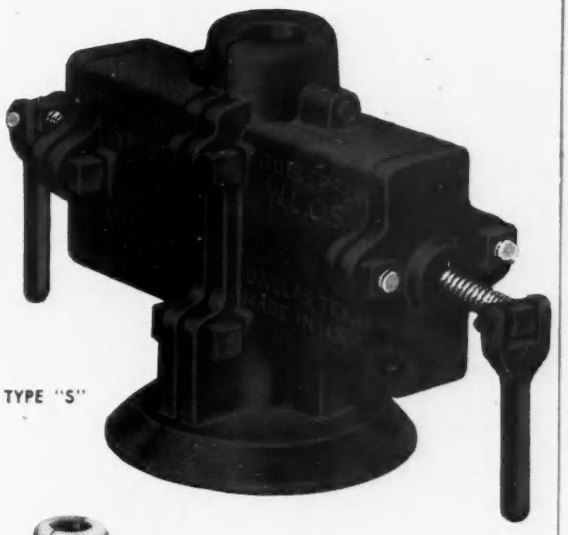
•

Royal R. Bush, 74, retired California oil man, died March 10 in Pasadena, Calif. He organized the Bush-Voorhis Oil Company in Long Beach, Calif., in 1922 in partnership with Charles B. Voorhis.

CLEAN FLOOR SAFE DERRICK



TYPE "R"



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TYPE "D"

TYPE "B" RELEASING ATTACHMENT

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TYPE "D"—for tubing or casing. Two independent sets of rubbers, single end operation, make it cost more but still very economical. Pin or flange adapter connection.

Non-sparking brass bushings and guides throughout . . . long-wearing rubbers . . . finest Guiberson precision construction.

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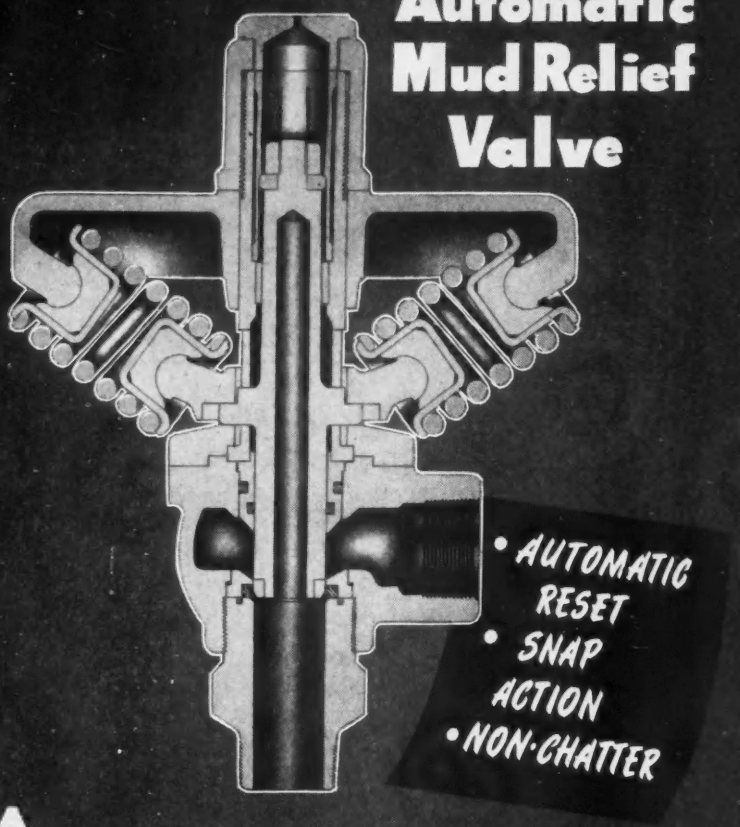

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Companies in the News

SHELL OIL COMPANY is opening a district office in Salt Lake City to be responsible for the company's exploration activities in northeastern Utah. It is the third one to be opened since Shell began preliminary work nine years ago in the Rocky Mountain region.

W. W. Woodward has been appointed district geologist and will be in charge of the new Salt Lake office. Prior to this assignment, Woodward was located in California and Nevada. **D. O. Cole,** district leaseman from Casper, will be in charge of land activities in the new district.

•

MONTEREY OIL COMPANY OF TEXAS is the new corporate name of the firm formerly known as Jergins Oil Company of Texas. It is a change in name only and involves no change in business or operations of the company.

The company's activities are carried on principally in Southwest Texas. Headquarters are in San Antonio, with operations under the immediate direction of **Jerome J. O'Brien,** vice president and general manager.

The Company has production and active development operations on its properties in the Helen Gohlke (Wilcox) field, the South Coletto Creek field, the Cologne area of Victoria County, and in the McKee area of Crane County, Texas. Also scheduled for immediate drilling are a number of exploratory wells on acreage held by the company in Texas.

•

GULF OIL CORPORATION, in observance of its 50th anniversary, has published "Since Spindletop . . . A human story of Gulf's first half-century," by Craig Thompson. The 109-page book begins with the history of the company's early years and the petroleum pioneers who founded Gulf. The company's further achievements are recounted and illustrated, and Gulf's present widespread holdings are briefly outlined. Primarily, the book is not so much a factual record of Gulf's activities as the story of its growth through the leadership of such men as William Larimer Mellon.

•

D. D. FELDMAN OIL AND GAS has opened East Coast offices in New York at 270 Park Avenue. W. B. Uderski, former chief of the petroleum and coal division of United National Relief and Rehabilitation Administration, is in charge of the office.

•

SEMINOLE OIL & GAS CORPORATION has established a main operating office in the Tri-State Insurance Building at Tulsa. The office is under the direction of Wallace B. Pardoe, who is in charge of the company's operating and development program.

•

SKILES OIL CORPORATION, Mt. Carmel, Ill., has opened a Mid-Continent office at Tulsa with **H. D. Melton,** production superintendent, in charge and **H. C. Maymon** head of the land and title department. The company is a large independent operator and engages in waterflood operations in Kansas and Oklahoma.

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...for restoring lost circulation

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Associations

TO THE TUNE of "Hail, Hail the Gang's All Here," which was adopted as the official song, the Tulsa Chapter of Nomads inaugurated officers for 1952. Joining in the chorus are (front row, left to right) Opie Dimmick, Century Geophysical Company, president; R. E. Kirberger, Unit Rig and Equipment Company, vice president; Gilbert Swift, Well Surveys, Inc., secretary; J. S. George, Hughes Tool Company, assistant secretary; Arch Campbell, General Motors Corporation, treasurer; R. C. Glover, Baker Oil Tools, Inc., assistant treasurer; J. H. Beesley, Baroid Sales Division. National Lead Company, sergeant-at-arms; Don L. Collins, Republic Supply Company, deputy sergeant-at-arms; G. F. Coons, National Tube Company, regent. (Back row, left to right) Frankie Masters, nationally known orchestra leader who played at the Chapter's annual dinner dance; and H. M. Cooley, Bethlehem Steel Company, outgoing president. Cooley and Coons will represent Tulsa Chapter Nomads on the National Board of Regents for 1952.

Independents to Hear Brown At Columbus Mid-Year Meet

Bruce K. Brown, Washington, D.C., deputy administrator of PAD will be the principal speaker at the mid-year meeting of the Independent Petroleum Association of America in Columbus, Ohio, April 28-29.

Kenneth P. Milliken, general manager of Dunn-Mar Oil & Gas Company, is chairman of general arrangements. Subcommittee chairmen are W. E. Ferguson, Ohio Fuel Gas Company, entertainment; Jack Cashell, Preston Oil Company, reception; D. T. Ring, Waverly Oil Workers Company, finance; and Roy B. Weed, consulting geologist, transportation.

Ring is a member of the executive committee of IPAA, and Cashell and Weed are directors for Ohio. Clyde M. Foraker, president of Ohio Oil & Gas Association, and Ira M. Korst, executive secretary of the state organization, also are active in planning the IPAA session.

PAD is claimant agency for the petroleum industry under the Defense Production program. Brown was instrumental in organizing the agency, under Interior Secretary Oscar Chapman. He has announced he will retire as head of the agency and return to private business next June.

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Greatest Name in Cable Tools

Fig. 179 Acme W. L. Knife Cutters

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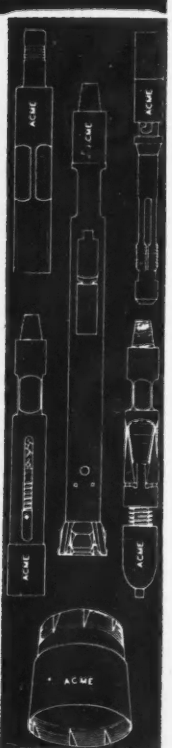

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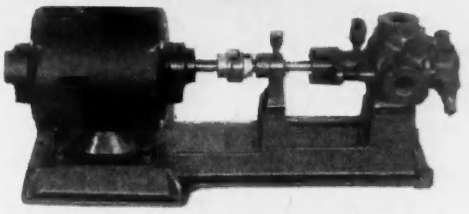

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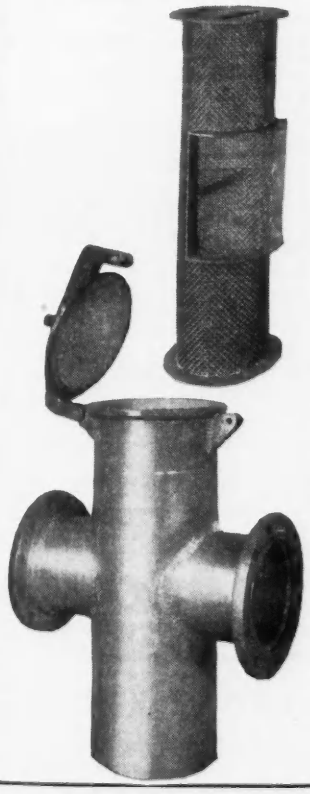

S & R Pump Suction STRAINER

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The main steel barrel of the unit is 13⅜" OD, 36" long. It can be furnished with inlets and outlets for 6", 8", or 10" suctions. The straining unit is held in this barrel by a steel plate cap which is fastened to a yoke; flanged ring on top is fitted with an O ring. T handle on top is easily adjusted by hand and assures a pressure tight seal.

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Associations

TO THE TUNE of "Hail, Hail the Gang's All Here," which was adopted as the official song, the Tulsa Chapter of Nomads inaugurated officers for 1952. Joining in the chorus are (front row, left to right) Opie Dimmick, Century Geophysical Company, president; R. E. Kirberger, Unit Rig and Equipment Company, vice president; Gilbert Swift, Well Surveys, Inc., secretary; J. S. George, Hughes Tool Company, assistant secretary; Arch Campbell, General Motors Corporation, treasurer; R. C. Glover, Baker Oil Tools, Inc., assistant treasurer; J. H. Beesley, Baroid Sales Division. National Lead Company, sergeant-at-arms; Don L. Collins, Republic Supply Company, deputy sergeant-at-arms; G. F. Coons, National Tube Company, regent. (Back row, left to right) Frankie Masters, nationally known orchestra leader who played at the Chapter's annual dinner dance; and H. M. Cooley, Bethlehem Steel Company, outgoing president. Cooley and Coons will represent Tulsa Chapter Nomads on the National Board of Regents for 1952.

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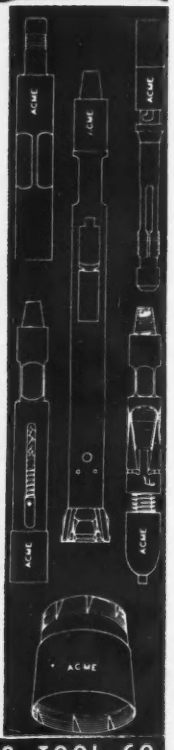
Unique, patented design of life-long driller. Every part meets ALL correct-steel, controlled heat-treatment and precision-crafted standards, making Acme's famous-favorites since 1900.



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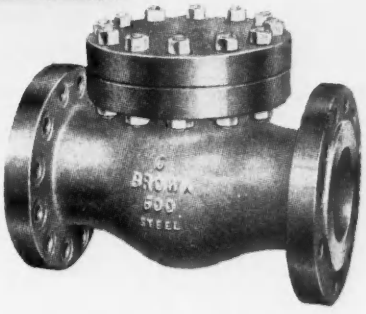

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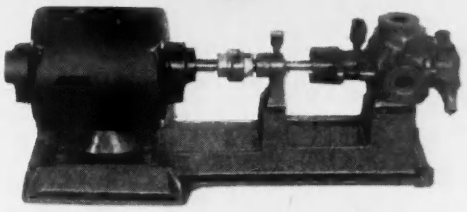

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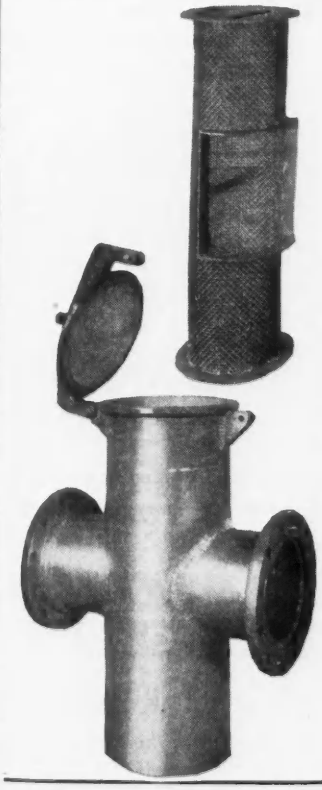

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ASSOCIATIONS

NEW OFFICERS of the Southwestern District, API Division of Production, include, left to right, Roy E. Carter, Ray Elner, R. B. Chesney, Bruno R. Schabarum, Olin Bell (past chairman), and J. B. Jones.

Schabarum Is New Chairman Of API Southwest Division

B. R. Schabarum of the Carl B. King Drilling Company, Midland, Texas, was elected chairman of the Southwestern District, API Division of Production, at the annual spring meeting of the group.

Attendance records were broken at this year's meeting, with a total registration of 916 by noon of the last day. That was the highest paid attendance in the history of district meetings in the five API districts.

Vice chairmen elected were: J. W. Roche, Wichita Falls, Texas, Shell Oil Company, for North Texas; R. B. Chesney, Benton, La., Sunray Oil Corporation, for Arkansas and North Louisiana; J. A. Williams, Jr., Gladewater, Texas, The Texas Company, for East Texas; S. C. Oliphant, Houston, Stanolind Oil and Gas Company, for Texas Gulf Coast; Louis Davis, Dallas, the Atlantic Refining Company, for Central Texas; W. W. Ramseur, Laurel, Miss., Gulf Refining Company, for Alabama-Mississippi; Roual Dunn, Hobbs, N. M., Phillips Petroleum Company, for New Mexico; Roy E. Carter, Kermit, Texas, Carter Foundation Production Company, for West Texas; E. N. Van Duzee, New Orleans, Shell Oil Company, for South Louisiana; J. B. Jones, San Antonio, Halliburton Oil Well Cementing Company, for Southwest Texas.

Other officers are Ray Elner, Fort Worth, Kobe, Inc., secretary-treasurer, and Olin G. Bell, Houston, Humble Oil & Refining Company, chairman of the advisory committee.

Illinois Geologist and Author Wins AAPG's President's Award

Raymond Siever, associate geologist in the coal division, Illinois State Geological Survey, was the winner of the 1952 President's Award of the American Association of Petroleum Geologists.

The annual award is made to the author, under the age of 35, of the "most significant original contribution to petroleum geology" published in the monthly Bulletin of the Association. Selected by a national medal award committee, the paper was entitled "The Mississippian-Pennsylvanian Unconformity in Illinois."

Presentation of the award was made at the 37th annual meeting of the A.A.P.G., meeting jointly in Los Angeles with the Society of Economic Paleontologists and Mineralogists and the Society of Exploration Geophysicists.

Thompson Is Chief Speaker On Oil Conservation Program

Lt. Gen. Ernest O. Thompson, senior member of the Texas Railroad Commission, will address the dinner meeting of an Oil and Gas Conservation Institute to be held April 2-3, at the University of Oklahoma, Norman, on "My Experiences in Oil and Gas Conservation As A Member of A State Regulatory Body."

The Institute is being held under the cooperative sponsorship of the schools of geology, engineering and law at O.U., and the oil and gas industry. The two-day program is made up of addresses on various phases of oil and gas conservation, as well as a panel discussion of practical problems of conservation.

Kentucky Oil Men to Meet

The Kentucky Oil & Gas Association will hold its 1952 meeting in Lexington, Ky., June 19-20, at the Phoenix Hotel and the Hotel Lafayette.

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PARMACO PRODUCTS
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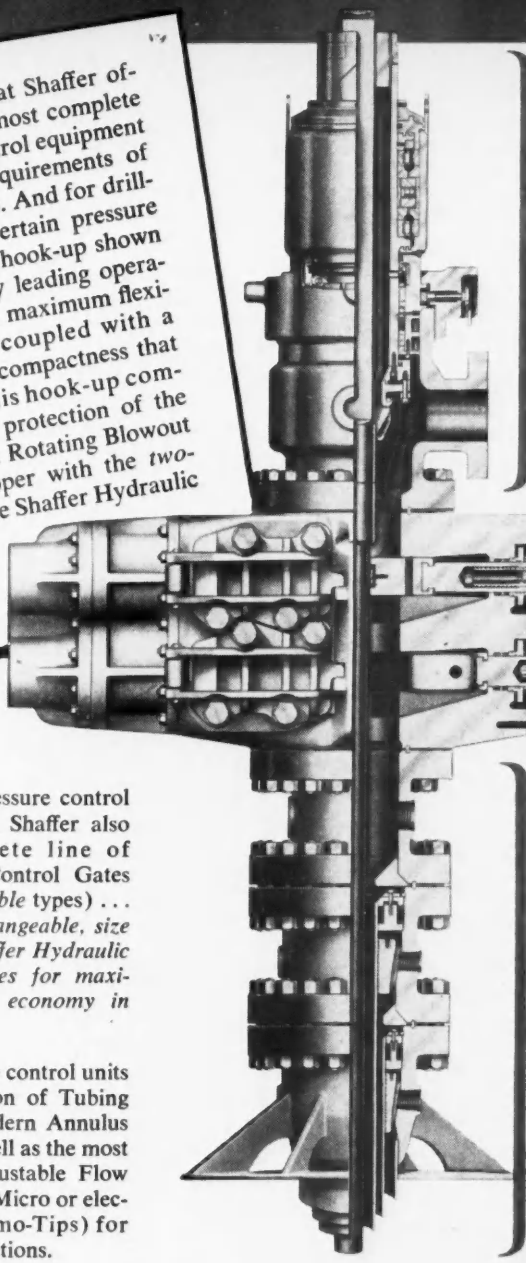
3 REASONS *why this Shaffer Hook-Up is the* Choice of Leading Operators!

It is a recognized fact that Shaffer offers the oil industry the most complete selection of pressure control equipment to meet the varying requirements of different field conditions. And for drilling under high or uncertain pressure conditions, the Shaffer hook-up shown at right is preferred by leading operators because it permits maximum flexibility of operation, coupled with a degree of safety and compactness that are unsurpassed. This hook-up combines the *automatic* protection of the Shaffer Combination Rotating Blowout Preventer and Stripper with the *two-way* protection of the Shaffer Hydraulic Double Cellar Control Gate . . .



In addition to the pressure control units shown at right, Shaffer also provides a complete line of *Mechanical* Cellar Control Gates (both *Single* and *Double* types) . . . *and rams are interchangeable, size for size, between Shaffer Hydraulic and Mechanical Gates for maximum simplicity and economy in field operations.*

Other Shaffer pressure control units include a full selection of Tubing Heads (featuring modern Annulus Flange types) . . . as well as the most complete line of Adjustable Flow Beans (with Conical, Micro or electrically-heated Thermo-Tips) for use in the flow connections.

1 ***THE SHAFFER COMBINATION ROTATING BLOWOUT PREVENTER AND STRIPPER*** **provides—*in one unit*—every necessary feature for successful and simplified pressure control while the drill string is in the hole . . .**

- **It *automatically* maintains a continuous seal around different shaped elements in the drill string — square, hexagon or round — regardless of whether the string is rotating, being raised, lowered, or is stationary.**
- **The seal *automatically* expands and contracts to fit the varying diameters of drill pipe, tool joints, couplings and drill collars.**
- **Bits, reamers and other abnormally large tools can be easily passed through the unit by merely turning the Quick Releasing Bonnet 1/6 turn and removing the sealing assembly. It's simple, quick!**

With no valves to open or close, nothing to remember, *nothing to forget* in the excitement of pressure emergencies, this unit gives *continuous* protection while the drill string is in the hole!

2 ***THE SHAFFER HYDRAULIC DOUBLE CELLAR CONTROL GATE*** **provides—*in one unit*—rams for shutting off the well when pipe is in the hole, as well as rams for sealing off open hole.**

- **Rams are opened and closed by *direct* hydraulic drive in a completely enclosed unit. No complicated yokes or secondary connections, no exposed moving parts to become wedged or damaged.**
- **Even in sizes as large as 13⅝" (12" Series 900) the complete unit, including *two* ram compartments, requires only 30" cellar height—smaller sizes even less!**
- **Rams can be easily changed—whether the pipe is in or out of the hole — by simply opening two doors in the side of the gate . . . the simplest, quickest ram changes in *any* gate!**

There are many other vital advancements—and the same basic features are also available in the Shaffer Hydraulic *Single* Cellar Control Gate, if this design desired.

3 ***SHAFFER LANDING AND CASING HEADS*** **are recognized throughout the industry for their rugged dependability and adaptability to various suspension and pack-off requirements. The bottom unit at left is a Shaffer Base Head from which two strings of casing are suspended and packed-off with maximum compactness . . . and in the Head above it a third string is suspended and packed off.**

With the casing program known in advance, the complete drilling and casing program can be completed without changing drilling connection, including gates, either in size or length during drilling of well.

Other types of Shaffer Heads and packing arrangements—including Shaffer Combination Base, Casing and Tubing Heads in *one unit*— are also available to meet virtually any well-completion requirement.

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Kansas-Oklahoma Oil Men Select Association Officers

T. H. Marshall, Anderson-Prichard Oil Corporation, Oklahoma City, was re-elected president of the Kansas-Oklahoma division, Mid-Continent Oil and Gas Association.

Other officers are Villard Martin, Tulsa, first vice president; W. G. Tierney, Derby Oil Company, Wichita, vice president for western Kansas; Carl Weiner, Chanute, vice president for eastern Kansas; A. W. Ambrose, Cities Service Oil Company, Bartlesville, vice president for Northern Oklahoma; Ward S. Merrick, Ardmore, vice president for southern Oklahoma; Dean A. McGee, Kerr McGee Oil Industries, Inc., Oklahoma City, vice president for western Oklahoma; Clarel M. Mapes, Tulsa, re-elected secretary and treasurer.

IOCC to Meet in Phoenix

The 1952 spring meeting of the Interstate Oil Compact Commission will be held in Phoenix, Ariz., May 9-10, Governor Sid McMath of Arkansas, IOCC chairman, announced.

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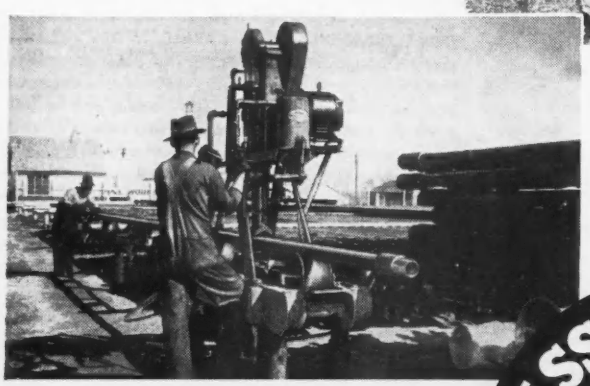
No need to tie-up operating capital in drilling equipment! Just call "Associated"! Drill pipe and tools are maintained in excellent condition, ready for immediate delivery on rental basis. All six yards (listed below) are equipped to give you fast 24-hour service!

(*Right*) All pipe returned to our yards is steam cleaned and rigidly inspected.



(*Left*) Returned pipe is straightened, repaired to first class condition and threads properly lubricated before being replaced on racks.

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ASSOCIATED A OIL FIELD INC. RENTALS

Independents Advance Huff To Assist Executive Manager

I. C. (Cleve) Huff, Jr., has been named assistant to C. E. Buchner, executive manager of Independent Petroleum Association of America. Huff served as field representative of IPAA in Houston from 1941 until September, 1950, when he was transferred to the Tulsa headquarters as membership director. He worked for Pawnee Oil Production Company at Tulsa and for Cree and Hoover, drilling contractors and oil producers at Pampa, Texas.

I. C. Huff, Jr.

Pipe Line-Safety Conference Is Scheduled for April 20-25

The third annual Products Pipe Line Conference, and the fifth mid-year meeting of the Safety and Fire Protection Committees of the American Petroleum Institute will be held concurrently in Fort Worth during the week beginning April 20.

The Pipe Line Conference will be held in the Blackstone Hotel April 20-24. The safety sessions will be held in Hotel Texas April 21-25.

The program chairman, G. F. Brigance, of Socony-Vacuum Oil Company, has arranged for seven papers to be presented at an all-day symposium.

The conferences are sponsored by the subcommittee on Products Pipe Line Technology of the API's Division of Transportation, of which J. W. deGroot is chairman. W. H. Morris, of Sinclair Pipe Line Company is chairman of the committee on arrangements for the meeting.

Cordilleran Geologists Plan 48th Annual Meeting in April

The Cordilleran Section of the Geological Society of America will hold its forty-eighth annual meeting on Friday and Saturday, April 11-12, on the University of Arizona's campus under the sponsorship of the Arizona Geological Society.

Members of a formal panel discussion will be Hugo Benioff, W. H. Easton, H. N. Fisk, James Gilluly, Jean Verhoogen and Frank Turner.

Representatives of professional, commercial, and government agencies will present an informal panel discussion of the types of geological training desired and the opportunities that exist for advanced students.

Texas A. & I. Offers Seventh Gas Technology Short Course

The seventh annual Short Course in Gas Technology, offered by Texas College of Arts and Industries and sponsored by the Southern Gas Association, will be held May 29-31 at Kingsville, Texas.

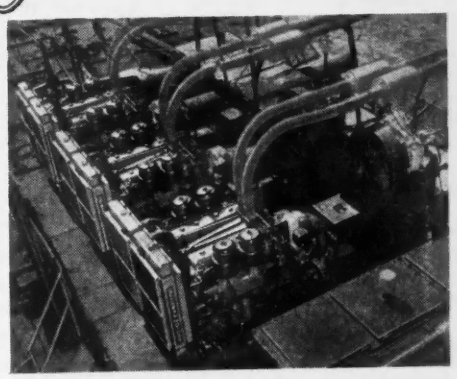
The course will cover problems encountered in production, transmission and utilization of gas. Frank H. Dotterweich of Kingsville is chairman.

GM Diesel
Case History No. 5211-12

USER: Al Buchanan Drilling Company, San Antonio, Texas. Rig No. 9.

INSTALLATION: Three GM Diesel "Twin 6" torque-converter units, powering a Clark-Ideco PR-1000 rig. Replaced other GM Diesels that had given four years' continuous trouble-free service. Bought new GM Diesels to get dual-fuel torque-converter units.

PERFORMANCE: Since July, 1950, engines have drilled more than 85,000 feet of hole (one well 12,000 feet deep). Maintenance costs negligible and owners report, "we are happy to recommend GM Diesels."



This Diesel Gives Drillers More Power with fewer units . . . less weight . . . less space

GM Diesel torque-converter units are the favorite of drilling contractors for dependable, low-cost operation. Their compact 2-cycle design gives them plenty of smooth, fast-stepping power in lighter, more compact units. That means quicker round trips—faster, cheaper moves and rig-ups.

With most parts easy to inspect and service, GM Diesels are also much easier to maintain. High interchangeability of parts reduces inventories—lowers repair costs. And you can count on your GM Diesel distributor, listed below, for quick, efficient service.

DETROIT DIESEL ENGINE DIVISION
GENERAL MOTORS, DETROIT 28, MICHIGAN
SINGLE ENGINES...33 to 275 H.P. MULTIPLE UNITS...Up to 600 H.P.

It pays to Standardize on

Write for booklet "A $10,000,000 Horsepower Insurance Policy" that tells you why.

GM
GENERAL MOTORS
DIESEL POWER

EQUIPMENT AND SERVICE SUPPLIERS' NOTES

BAASH-ROSS COMPANY sales personnel in the Texas and Gulf Coast areas who met at a recent conference in Houston are shown above. Left to right are H. Z. (Zeke) Browning, Corpus Christi; George Cook, Houston; Charles Laudermilk, Shreveport; Cecil Laws, Houston; Gene Buckner, New Iberia; Ken Jones, Albert Schoettler, John Terry (Gas Engine division), J. L. Barnett, Jr., E. J. Frederick, and E. M. Gearke, all of Houston. Gearke is general sales manager for all Baash-Ross operations served by the 17 manufacturing plants and service shops.

200 Attend 12th Annual Meeting Of Continental Sales Organization

The Continental Supply Company held its 12th annual meeting in Houston March 24 and 25. District managers, assistant district managers and field representatives from the company's 80 stores and offices, as well as principals in the Sales and Engineering divisions, were among the 200 present. Also participating were executives of Continental and several of its associated manufacturing companies.

Under the theme of "Know Your Products," each meeting session was one of demonstration so that all personnel would be fully informed on latest developments in equipment.

All day Monday was spent in the plant of Emsco Derrick & Equipment Company, where the group inspected various pieces of Emsco equipment, including the new J-1100 and J-1400 rigs. Explanatory talks were given by engineering and construction specialists.

The Continental Supply Company warehouse was visited Tuesday morning. After an inspection of those facilities the group went to the Broderick & Bascom Rope Company plant for lunch, followed by an inspection tour. A general session closed the meeting.

Executives of Continental attending the meeting were W. J. Morris, chairman of the board; Frederick M. Mayer, president; Frank I. Brinegar, executive vice president; Noble A. Endicott, vice president in charge of Gulf Coast operations; Dan Bailey, vice president in charge of finances; and Jack A. Mussler, general manager of sales.

Representing an associate manufacturer, Youngstown Sheet and Tube Company, were W. E. Watson, first vice president and John de Hetre, manager of oil country tubular sales.

Emsco Derrick & Equipment Company was represented by W. T. Powell, executive vice president; Paul Courtney, vice president; S. A. Martin, Houston plant manager; J. T. Tucker, sales manager; and A. A. Ashton, chief engineer.

Others in attendance were E. F. Schaefer, president, Gardner-Denver Company; Joe H. Bascom, vice president, Broderick & Bascom Rope Company; H. H. Peters, vice president, Technical Oil Tool Corporation; Ben F. Ruether, vice president, New York Belting & Packing Company; Martin Walter, Jr., president and Robert A. Snyder, vice president, of New Bedford Cordage Company.

New Wichita Falls Store Manager Named by Oil Well Supply Division

Ralph Crowe has been appointed manager of the Wichita Falls, Texas, store of Oil Well Supply Division, U. S. Steel Company. Crowe, who has been manager of the Snyder, Texas, store for the past 18 months, succeeds Fred Wellman, who has been named manager of the new store and district warehouse at Odessa, Texas.

Crowe joined "Oilwell" in January, 1944, as a warehouseman in the Anson, Texas, store.

Halliburton Adds Director; Opens New Division in West Texas Region

Frank A. Morgan, vice president of Richfield Oil Corporation, Los Angeles, has been named a director of Halliburton Oil Well Cementing Company, Duncan, Okla.

Halliburton also announced that the Midland division has been divided geographically and a new division headquarters has been established at Lubbock, Texas, in the Lubbock National Bank Building.

C. T. McGuire is division manager in Lubbock, and J. L. Muse, formerly of the Midland division, is assistant division manager.

Other personnel transfers include those of W. L. Hughes, from Houston to Midland as assistant division manager; Elmer Lawrence, from Great Bend, Kansas, as assistant division manager at Evansville, Ill.; A. O. White, from Flora, Ill., to Great Bend as assistant division manager of Wichita division; J. B. Jones, from San Antonio to Houston as contact man; and W. A. Wallace, from Houston to Duncan as formation testing supervisor.

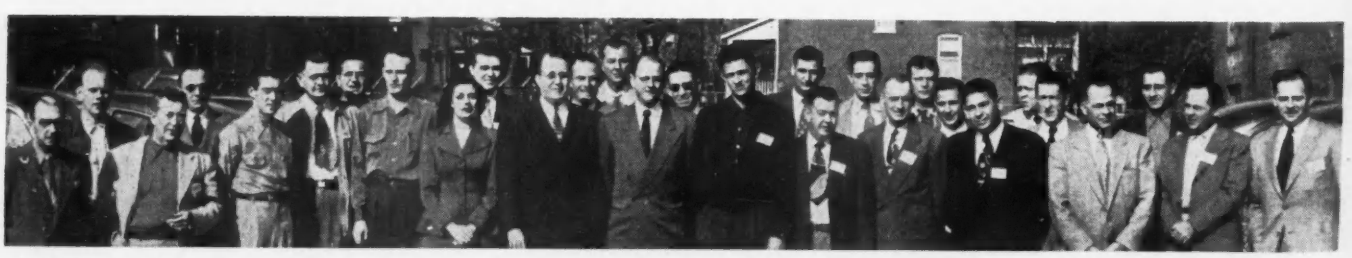
Drilling Equipment Representative Returns to Australia from U. S.

J. Bayliss, representative for Tutt Bryant, Ltd., of Australia, is returning to that country after a trip around the world, begun last November. Part of the journey was spent in Italy, where Bayliss, a drilling equipment engineer formerly with Shell Development Company, made a detailed study of drilling for geothermal steam, an operation soon to start in New Zealand.

Tutt Bryant, Ltd., represents National Supply Export Corporation, Reed Roller Bit Company and Geo. E. Failing Supply Company in Australia and New Zealand.

Advance Names Mid-Continent Agent

Advance Oil Tool Company announced that Hillman-Kelley has been appointed Mid-Continent sales and service representative for the Automatic Air-Powered Tubing Spider.



MEMBERS OF THE SALES FORCE of Larkin Packer Company, Inc., who attended the sales meeting in St. Louis are pictured. Left to right are G. F. Robinson, Ardmore; J. Morrison, Eldorado; J. A. Hill, Houston; C. F. Warner, Los Angeles; J. B. Wetsel, Abilene; I. P. Allen, Oklahoma City; D. O. Chism, Hobbs; J. J. Larkin, Jr., St. Louis; Dorothy Conkin, St. Louis; J. B. Hollingsworth, Houston; W. H. Larkin, St. Louis; R. B. Miller, Liberal; A. Hokey, Midland; T. E. Alexander, Houston; F. S. Dewel, Casper; F. A. Proctor, Big Spring; G. E. Beeman, Victoria; W. Ford, Mt. Vernon; J. Meek, Evansville; E. D. Curran, Hoisington; J. Brown, Big Spring; T. Michie, Wichita Falls; R. L. Ramby, Corpus Christi; F. E. Stevens, Laurel; B. J. Jostrand, St. Louis; O. L. Wooten, Edmonton; F. Cook, Odessa; J. C. Green, Shreveport; P. N. Sullivan, Tulsa.

YOU'LL FIND *LeBus Grooving Service* THROUGHOUT THE OIL PATCH

Strategically located throughout the Oil Country are fully trained Sales and Service Representatives for LeBus Grooving and Wire Line Spooling service. These men are readily available to answer any questions you may have regarding Wire Line grooving and are on call to service your rig whenever needed. If you haven't grooved your rig . . . call on one of LeBus' Sales Representatives and let them show you the advantages of LeBus Grooving and Wire Line Spooling service and how this service can save you valuable drilling time and money.

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P. O. Box 1618
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EQUIPMENT and SERVICE SUPPLIERS' NOTES

LUFKIN FOUNDRY AND MACHINE COMPANY'S annual sales conference this year coincided with the fiftieth anniversary of the company. Lufkin representatives who attended the meeting are pictured. Front row, left to right, are R. C. Thompson, Dan W. Martin, M. L. Wilkinson, L. A. Little, W. W. Trout, A. E. Cudlipp, C. M. Wooten. Second row, left to right: D. A. Reid, Jack Gissler, Ben C. Sargent, Jr., E. H. Bounds, Robert Lang, Bayo Hopper, A. V. Simonson, Vernon Glenn, Louis Fincher. Third row, left to right: Newell Lynch, Robert Poland, Charles Dyer, W. T. Crowder, Jr., B. C. Burnette, E. P. Trout, V. J. Fawcett, Byron Robbins, J. E. McGranahan, Homer Thrash. Fourth row, left to right: Bob Spaulding, A. E. Caraway, Ernest Slaughter, Jr., G. W. Nichols, T. A. Banta, John W. Swanson, Jr., W. H. Miner, Elvin Read, Harold D. Bowerman, L. Carl Frazier, Hubert Dyer, Cooper Richards, T. L. Bowers, Val Gallia, G. L. Vickrey. Top row, left to right: W. A. Kirkland, H. H. Muller, Oliver McKay, Ed Terrill, Jr., Lewis W. Breeden, J. Taylor Hood, Jack Read, R. S. Miller, John D. Mettauer, Fred Griffin.

WAUKESHA SALES AND SERVICE, Inc., personnel and their guests are pictured at the annual sales meeting in Houston. Left to right, first row, are H. A. Davis, district manager of Twin Disc Clutch Company; G. A. Duncan, branch manager of Waukesha Motor Company, Tulsa; C. O. Zagst, J. L. Kluppel, L. M. Pearce, Jr., president of Waukesha; L. M. Pearce, chairman of the board of directors; L. E. Hodges, W. A. Shalen, W. J. Buehring, Earl Gray, and B. Ball, all of Houston; second row: H. D. Matthews, F. L. Wiley, S. W. Wacey, L. D. Lynch, all of Wichita Falls; Leon Miller, Pampa; Harry Goss, F. L. Williams, G. C. Shows, Ann Caldwell, I. J. Slay, Bert Coleman, all of Houston; J. B. Krenek and David Brey of New Iberia, La.; James S. Warnick, George E. Swann, L. A. Bell, and George Axmacher, all of Dallas; third row: C. P. Cummings, F. M. McCarthy, J. T. Wilcheck, G. C. Sies, all of Odessa; Cecil Hobdy of Lubbock, Tom Jenkins of Snyder, F. A. Chance, M. D. Russell, Jim Ramsey, all of Kilgore; H. R. Schaumburg, Harold Sherrod, Shreveport; W. L. Jenkins, R. F. Park, Corpus Christi; O. E. Bishop of Pharr, and Austin Webb of Corpus Christi.

GROVE REGULATOR COMPANY executives and district field representatives gathered at their annual sales meeting at the Grove plant in Emeryville, Calif. Among those attending the sessions were (front row) E. H. McMenemy, office manager, Houston; C. W. Garrison, office manager, New York; J. A. Records, district engineer, Lafayette, La.; J. D. Hicks, Corpus Christi, Texas; L. D. West and George Doty, Emeryville; (second row) A. V. Bryant, chief engineer, Emeryville; L. R. Van Arsdale, Tulsa; L. S. Robb, Dallas; W. H. Orth, Los Angeles; K. F. McIntire, H. A. Ward and M. H. Grove, Emeryville; (back row) C. B. Truitt, Southwestern division sales manager, Houston; W. G. Folsom, Odessa, Texas; J. A. Mattson, New York; J. W. Collins, E. E. Mann and H. Wolpman, Emeryville.

EQUIPMENT and SERVICE SUPPLIERS' NOTES

Oil Field Equipment Corporation Elects G. G. Guiberson President

Gordon G. Guiberson, until recently chairman of the Executive Committee of The Guiberson Corporation, has been elected president of the company. Guiberson has previously been vice president and general manager and sales manager. He has spent his entire business life in the oil industry, specializing in development, production and equipment problems.

G. G. Guiberson

Officers of the corporation who will assist the new president are S. A. Guiberson, Jr., chairman of the board; Alex P. Smith, executive vice president; Allen Guiberson, vice president; N. G. Guiberson, vice president; William F. Neale, vice president; A. J. Wallis, secretary; C. H. Ballard, treasurer; T. V. Terry, assistant secretary-treasurer.

Byron Jackson Company Appoints Earl M. Rees Manager of Export

Earl M. Rees has been appointed manager of export for the Oil Tool and PB division of Byron Jackson Company and BJ Service, Inc. Rees replaces O. W. Morgan, Jr., resigned.

Earl M. Rees

Rees joined Byron Jackson in 1946 when the Patterson-Ballagh Corporation became a wholly owned subsidiary. During the past 24 years, Rees has visited most of the oil fields overseas.

Two Sales Department Key Changes Are Announced by Oil Center Tool

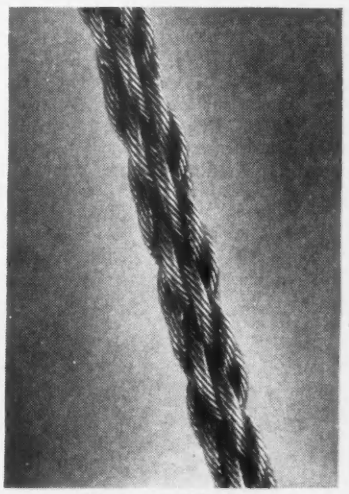
M. E. (Mike) Hunter has been named manager of the Southwest Texas district of Oil Center Tool Company, Sales department, with headquarters at Corpus Christi. He has been an employe of O-C-T since 1937.

M. E. Hunter

Myles C. Esterak

Myles C. Esterak has recently joined the O-C-T organization as sales representative in the Southwest Texas district with headquarters in Victoria, Texas. Before joining O-C-T, he worked for Republic Supply Company in Victoria.

Knot It! Kink It! ...IT WON'T HURT A Tuffy® SLING!



Patent No. 2,454,417

Get your FREE Tuffy 3-ft. sample sling and see for yourself how Tuffy's patented braided wire fabric makes an extra flexible sling. Tie it in knots, kink it, then see how easily it is straightened without damaging it in any way.

The reason is Tuffy's unique construction. (See enlarged photograph). Scores of wires are stranded into 9 parts, then machine woven into a wire fabric that has unusual flexibility and strength. Even cutting one of the 9 parts will not cause stranding.

11 Types of Tuffy Slings Available

There's a Tuffy Sling for *your* needs. If not, Union Wire Rope engineers will help work out special slings. Each one is proof-tested to twice its safe working load and the safe working load is stamped on metal tag attached to each sling. If you have your own rigging loft, Tuffy fabric is available by the reel.

MAIL COUPON FOR YOUR FREE SLING

See for yourself that all the things we claim for Tuffy Slings are true. A free 3-foot sample is yours for the asking. Just mail the coupon and your Union fieldman will deliver yours to you.

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Specialists in Wire Rope, Braided Wire Fabric and High Carbon Wire
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Gentlemen: Please have my Union Wire Rope Fieldman deliver my free Tuffy sling sample.

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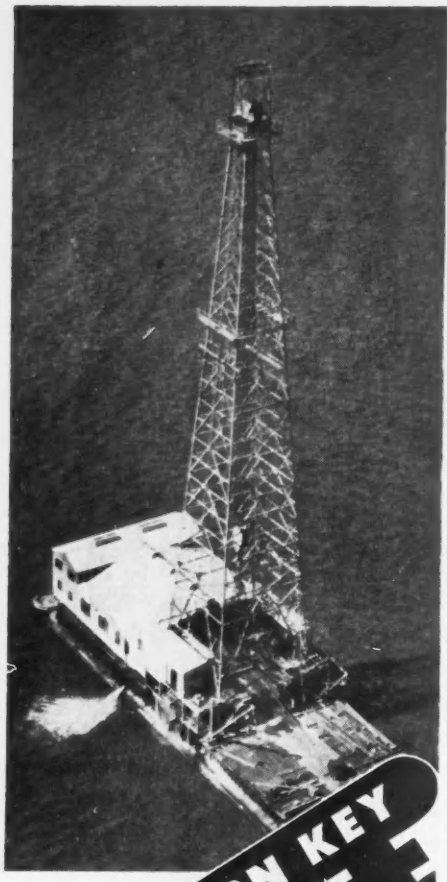

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DO THE COMPLETE JOB
with the machinery of your choice

From crown block to barge bottom, Levingston is prepared to accept the entire responsibility of constructing and rigging-up your submersible drill barges on a turn-key basis. You select the tools or equipment, and Levingston's experienced organization will install them for safe and efficient operation on marine locations.

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Orange, Texas

EQUIPMENT and SERVICE SUPPLIERS' NOTES

SALES AND OPERATING MEN of Welex Jet Services, Inc., gathered in Fort Worth for the company's general sales meeting. Top row, left to right, are Jack Smith, industrial engineer; Ray Williams, district manager, Hobbs, N. M.; John Sherrod, sales engineer, Midland, Texas; C. R. (Chick) Parker, district manager, Lindsay, Okla.; George Jefferis, manager of materials; K. L. White, assistant district manager, Odessa, Texas; Bob Burns, sales engineer, Duncan, Okla.; Joe Wooldridge, sales engineer, Wichita Falls, Texas; Joe Beard, district manager, Houston; John Flemming, district manager, Corpus Christi; Art Harper, district manager, Wichita Falls; W. O. Foerster, district manager, Falfurrias, Texas; Ray Porter, assistant manager of materials; E. L. Blackman, division sales manager, Houston; O. B. Avent, district manager, Ardmore, Okla.; L. B. Putman, assistant district manager, Lindsay. Second row: W. L. Carwile, Jr., division manager, Oklahoma City; W. O. Satterwhite, division manager, Odessa; W. H. Griffin, division manager, Houston; Dr. W. C. Ford of the Psychological Service Institute, Houston, who was a speaker at the meeting; R. H. McLemore, executive vice president; T. R. Weymouth, II, secretary-treasurer; Tom Painter, operations manager; Blake Caldwell, chief engineer; A. M. (Bert) Birnie, general sales manager; W. K. Daggett, director of training. Bottom row: R. L. Robinson, research engineer; James E. Staugh, district manager, Kilgore, Texas; Howard Shireman, sales engineer; R. C. Starrett, assistant district manager, Hobbs; Ray Graham, design engineer; H. A. Bergman, sales engineer, Elk City, Okla.; W. B. Clark, assistant district manager, Wichita Falls; R. H. Cossey, district manager, Shawnee, Okla.

CAMERON IRON WORKS has opened a new warehouse and district headquarters offices at 900 Greffer Street, in Harvey, La. D. V. Clemons is district manager of the Louisiana, Mississippi, Gulf Coast division. B. B. Biggs has been appointed warehouseman. Other Cameron representatives in the Louisiana, Mississippi, Gulf Coast District include Fox Moses at Sulphur, Cal Grevemberg at Lake Charles, H. L. Evans and B. B. Bryan at New Iberia, George Myers at Baton Rouge, and W. C. Traweek at Houma.

A NEW WAREHOUSE STORE serving North Louisiana, East Texas and Mississippi has been opened in Shreveport by Oil Center Tool Company, Houston. The new store is at 327 Montgomery Street. H. C. Stewart is district manager.

EQUIPMENT and SERVICE SUPPLIERS' NOTES

Welex Jet Announces Appointment Of Birnie as Supervisor of Sales

Albert M. (Bert) Birnie has joined Welex Jet Services, Inc., as general sales manager, and will be responsible for the over-all supervision of Welex sales activities, working closely with the company's three division managers and ten district managers. He has offices at the Welex general offices in Fort Worth.

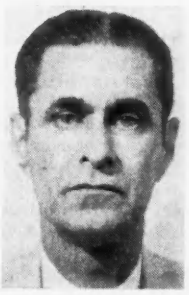
A. M. Birnie

Welex has recently expanded its services through the addition of radioactivity well logging services. At present the logging service is being offered in the Gulf Coast division, and will be expanded as rapidly as equipment deliveries permit.

Birnie was regional manager with Security Engineering Company for seven years before joining Welex Jet Services.

Export Sales Representative Tours South American Production Areas

Ross R. Chenault, associate of D. T. O'Connor, export representative of New York City, is now on an extended trip in South America, visiting all oil producing areas.



R. R. Chenault

Chenault and O'Connor represent Shaffer Tool Works, Frank Wheatley Pump & Valve Mfg., M. J. Crose Manufacturing Company, Inc., Mayhew Machine & Supply, Drilling & Service, Inc., and Mud Products, Inc.

Magnaflux Corporation Increases Laboratory Inspection Services

Magnaflux Corporation has increased the national coverage of its commercial laboratories, from five to 11 locations. They are in Chicago, New York, Hartford, Conn., Cleveland, Detroit, Wichita, Kansas, Dallas, Houston, Odessa, Los Angeles, and Oakland.

Laboratory and field inspection services are in addition to the regular manufacture and outright sale of inspection equipment. Inspection by Magnaflux personnel includes experienced consultation on how best to solve problems of causes of defects encountered in metal, and how to establish acceptance standards.

Baker Opens Williston Branch

Baker Oil Tools, Inc., has opened its new branch office and warehouse at Williston, N. D., to serve the Williston Basin area. Ben Spingath, formerly of Baker's Casper, Wyo., district office, will be the Williston branch representative. Warehouseman will be Gordon M. Anderson.

PEAK POLISH ROD LOADS ELIMINATED

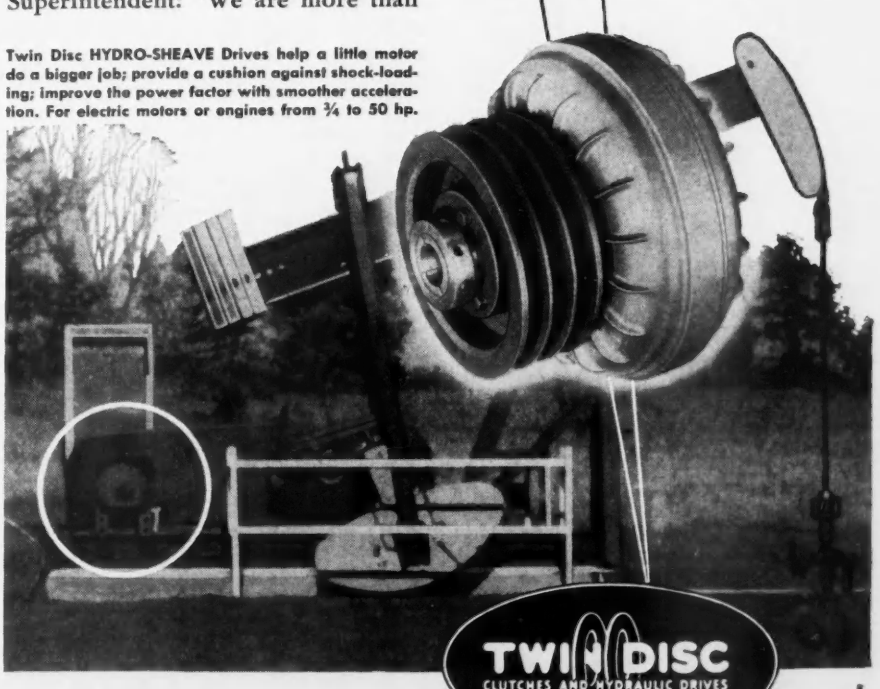
with TWIN DISC HYDRO-SHEAVE® DRIVES

Smoothing the power on 50 Cabot Pumping Jacks in the Ward S. Merrick holdings in the Graham Fox Pool and Bayou area of Carter County south of Lone Grove, Oklahoma, are Twin Disc's famous HYDRO-SHEAVE Drives. Bought to (1) increase pumping efficiency, (2) reduce initial motor cost, and (3) reduce excess current demands, these fluid drives *are* saving money on all three counts. That's why *more and more* HYDRO-SHEAVES dot the oil country.

Says Mr. Bob McChesney, Merrick Superintendent: "We are more than satisfied with the operation of the HYDRO-SHEAVE Drives due to smoother starting and the elimination of peak polish rod loads. Since using these units for the last three years we have had no belt failures. We are using 5 hp. motors on 4500 foot wells. Pumping units operating at this depth require 7½ hp. motors when not equipped with HYDRO-SHEAVE Drives."

Get the HYDRO-SHEAVE story from your nearest Twin Disc Hydraulic Drive dealer.

Twin Disc HYDRO-SHEAVE Drives help a little motor do a bigger job; provide a cushion against shock-loading; improve the power factor with smoother acceleration. For electric motors or engines from ¾ to 50 hp.



TWIN DISC
CLUTCHES AND HYDRAULIC DRIVES
REG. U.S. PAT. OFF.

TWIN DISC CLUTCH COMPANY, Racine, Wisconsin · HYDRAULIC DIVISION, Rockford, Illinois

BRANCHES: CLEVELAND · DALLAS · DETROIT · LOS ANGELES · NEWARK · NEW ORLEANS · SEATTLE · TULSA

Here's some "FIRST" Friends You should Know

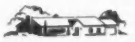
ELMO THOMPSON

JOE-BYRD

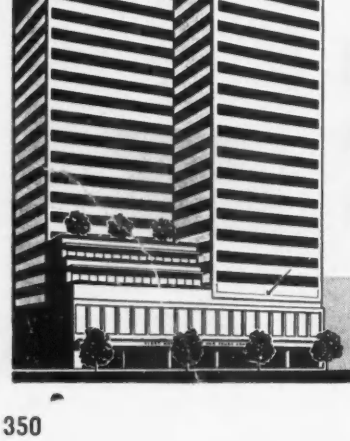
HARRY LANE

DICK WAGNER

DEAC RHODES

April showers bring May
flowers and the occasion of many
annual meetings...
To each and every one of which we send
the warmest greetings.....
You know, of course, that the FIRST
of TULSA is nationally known
As one of the best correspondents you
could possibly have on an oil loan
But we also want you to remember
This month, next, and even 'way
past next September
That in Real Estate,  Cattle,
Farming, Wholesaling
Retailing, Construction
and so forth
The chances are you'll go forth
And do better if this thought
you've nursed in and around Tulsa,
it's both pleasant and profitable
to think...FIRST!

1st of Tulsa



THE FIRST
NATIONAL BANK
AND TRUST COMPANY
OF TULSA

MEMBER FEDERAL DEPOSIT INSURANCE CORP.

When in Tulsa, You are cordially invited to visit our new building. See the FIRST mural interpretation of the famous Oklahoma Runs.

EQUIPMENT and SERVICE SUPPLIERS' NOTES

F. L. Bryan

A. H. Curran, Jr.

Two New Schlumberger Divisions Will Serve Pacific Coast Region

Schlumberger Well Surveying Corporation has formed two new divisions to serve the Pacific Coast area, and has named A. H. Curran, Jr., and F. L. Bryan managers of the new divisions.

Curran has been appointed Coast division manager with headquarters in Los Angeles and district offices in Ventura, Long Beach and Santa Maria. Curran, a graduate of the University of California at Berkeley, joined Schlumberger in December, 1945, working as a field engineer out of the Bakersfield office. In February, 1950, he was promoted to district manager at Long Beach, and assumed his present position in January, 1952. Curran served in the U. S. Coast Artillery Corps from 1942 through 1945 with the rank of captain.

Ventura district manager is C. R. Edgecomb, Jr., who joined Schlumberger in December, 1943, and was promoted to district manager in March, 1948.

G. C. Hepburn, Jr., newly appointed Long Beach district manager, joined Schlumberger in June, 1947, after serving three years as lieutenant in the U. S. Navy.

Will Plasch has been made district manager at Santa Maria. Plasch became a field engineer for Schlumberger in 1946. After an interlude in active duty with the U. S. Air Force, he returned to the company in 1951 at Ventura, and assumed his present duties in January of this year.

Bryan has been put in charge as manager of the newly created Valley division with offices at Bakersfield. Bryan was graduated from the University of California at Berkeley, and joined Schlumberger in 1941. In June, 1946, he was made district manager at Coalinga and in May, 1950, was promoted to area representative in the San Joaquin Valley. The Valley division is comprised of districts with offices located at Coalinga, Taft, King City, Sacramento and Bakersfield.

C. F. Gallagher, manager at Coalinga, has been with Schlumberger since 1946, assuming his present position in April, 1950.

Armour Kane, Taft district manager, joined Schlumberger in 1943, was transferred from Texas to California in 1950 and promoted to his present position on February 1, 1952.

D. G. Swiers, with Schlumberger as field engineer since April, 1947, was made King City district manager on February 1, 1952.

C. B. Evans, Sacramento district manager, assumed his present duties in January, 1952, after service since 1948 as field engineer in the Long Beach and Bakersfield districts.

J. H. Gallois, Bakersfield district man-

ager, has had a long career with Schlumberger. Born in Britanny, France, he received a B.S. degree from the Sorbonne (Paris University) and did graduate work in electrical engineering at the Ecole Universelle of Paris. He came to the U. S. as a member of the Schlumberger organization in 1925.

Hughes Forms New Division; Names Myers and Fleetwood to New Posts

The steady increase in drilling activity has resulted in Hughes Tool Company's creating a new large division by combining the northern part of West Texas with the Wichita Falls District.

Park L. Myers

C. W. Fleetwood

Park L. Myers, formerly manager of the Ark-La-Texas division, has been promoted to manage the new North Texas division with headquarters in Wichita Falls, Texas.

Myers' association with Hughes dates from 1937, when he started working for the company during summer vacations while attending the University of Texas. Myers brings with him wide field experience gained in many areas.

Clyde W. Fleetwood has been promoted to the managership of the Ark-La-Tex division with headquarters in Shreveport. Fleetwood has been with Hughes since graduating from Oklahoma University in 1935.

Fleetwood has had experience with Hughes in Oklahoma City, Seminole, Okla., Illinois and West Texas and, prior to his promotion, was district manager of the North Texas district at Wichita Falls.

Tri-State District Sales Manager Appointed by Beaumont Iron Works

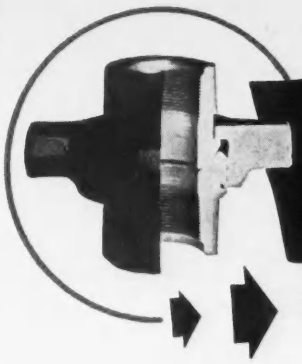
C. P. (Smiles) Gillespie is new district manager for sales of Beaumont Iron Works drilling and producing equipment in Louisiana, Mississippi, and Arkansas, with headquarters in Houma, La.

C. P. Gillespie

Gillespie has had more than 35 years' experience in the oil business, and has been associated with major oil companies and equipment manufacturers.

Store Personnel Are Promoted

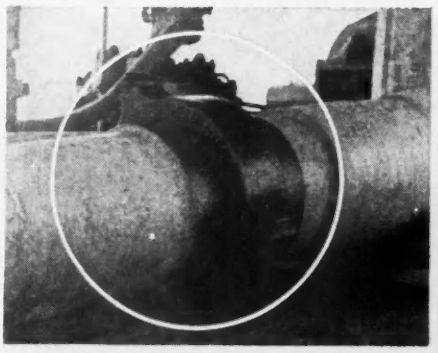
John B. Poulton, formerly floorman at the Liberal, Kansas, store of Continental Supply Company, has been promoted to manager. The former field salesman at Houma, La., Ralph A. Broussard, has been named store manager there.



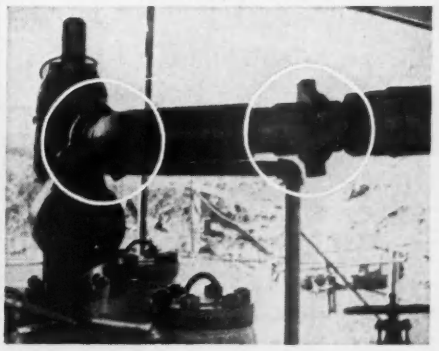
A TOUGH UNION for Tough Service . . .

. . . . the WECO FIG. 400

4000 p.s.i. Test
Sizes: 2", 2½", 3", 4", 5½" O.D., 6", 7" O.D., 8", 10"



The Weco Fig. 400 is ideal for pump suction connections.



Weco Fig. 400 unions save time in connecting up pump discharge lines.

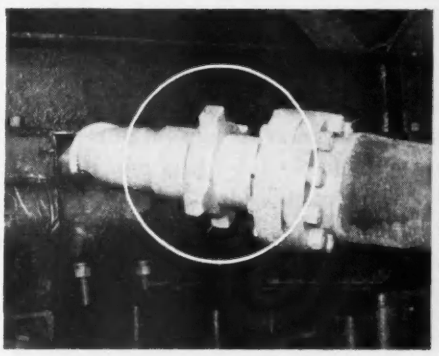
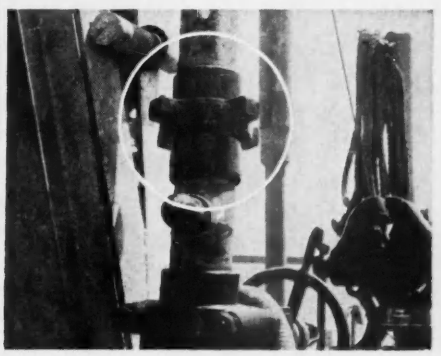


Fig. 400 Union on mud line.



4" Weco Fig. 400 Union on stand pipe.

● Unions in service on drilling rig lines get a lot of rough treatment. These mud, steam, water, oil, gas and other lines are made up and broken out frequently . . . carry fluids at high pressure with lots of vibration. The WECO Fig. 400 Union withstands more abuse in these tough services than any other union. Thicker sub end walls resist distortion . . . provide greater strength with less weight. The famous Weco ball and cone seat assures a perfect seal, every time.

SOLD EXCLUSIVELY THROUGH SUPPLY STORES

It's Wise to Standardize with... WECO...

WELL EQUIPMENT MFG. CORP.
Division of Chiksan Company
HOUSTON 1, TEXAS
Exclusive Sales Representative Outside Mid-Continent Area
CHIKSAN COMPANY
Brea, Calif. Chicago 3, Ill. Newark 2, N. J.
Export Sales: CHIKSAN EXPORT COMPANY, Brea, Calif. Newark 2, N. J.

Manufacturers and Distributors of Oilfield, Refining, Marine and Industrial Equipment

TUBE-KOTE, INC., HAS COMPLETED this new $50,000 office building on the 15-acre tract at 2520 Holmes Road, Houston. The new building brings to five the number of structures on the Tube-Kote lot. Pioneers in the development of thermo-setting plastic coating for oil field pipe and tubing, the company last year brought out a new product, TK-43, a rubbery copolymer baked-on plastic coating. L. E. (Larry) Heinen is president, John A. Croom, secretary, and W. H. Hopkins, treasurer.

What's your wall scraping job? Removing mud cake?...Increasing diameter for gravel packing? Cementing? *You can do the job faster and better —for less—with the Grant Hydraulic Expansion Wall Scraper!*

Its simple, rugged construction insures long, trouble free service. Blade expansion by pump pressure is controlled entirely from the rig floor. Seven scraper body sizes cover the range from 4¼" to 36". Three types—bull-nose, bottom hole and diamond point—will meet your specific scraping requirements.

Your nearby Grant branch is ready to furnish the Wall Scraper you want for your next job, and a service man stands ready to assist in running and operating the tool—day or night. *Call Grant—write direct for Bulletin 58 giving full details—or see the Grant Section in the Composite Catalog!*

Proven Grant Tools—Used Where Performance Counts

Hydrostatic Bailers	Bulletin No. 11
Liner Pullers	Bulletin No. 14
Pressure Releases	Bulletin No. 15
Casing Scrapers	Bulletin No. 17
Underreamers (Rotary)	Bulletin No. 24
Underreamers (Cable Tool)	Bulletin No. 27
Hole Enlargers	Bulletin No. 38
Reamers	Bulletin No. 43-A
Hydrostatic Perforation Cleaners	Bulletin No. 50
Dump Bailers	Bulletin No. 51
Roller Cutter Shale Bits	Bulletin No. 54
Sand Pumps	Bulletin No. 55
Well Cleanout Equipment	Bulletin No. 57
Wall and Bottom Hole Scrapers	Bulletin No. 58
Vertical Casing Scrapers	Bulletin No. 59

Write for Descriptive Bulletins on these Grant Tools

GRANT OIL TOOL COMPANY

Main Office and Plant
2042 E. Vernon, Los Angeles 11, Calif.
Branches Throughout California and The Mid-Continent

Subsidiary: MacClatchie Manufacturing Company

Mater Returns to South American Fields on Baker Oil Tools Business

B. E. (Ben) Mater is once more in South America for a six-month stay on business for Baker Oil Tools, Inc., and its subsidiary, Baker Transworld, Inc. This will be his eighth round trip to South American oil fields for Baker in the past five years. In addition, he flew about 50,000 miles during 1949-50 visiting practically all major oil producing areas of the world as a Baker representative.

Mater's current itinerary includes both Eastern and Western Venezuela, as well as Colombia. At Anaco, Venezuela, he will supervise construction of Baker Transworld's new warehousing and service facilities and residences for Baker representative Orlan Webb and his staff. Mater plans to return to the U.S. in August.

Colorado Fuel & Iron Corporation Elects Alwin F. Franz President

Alwin F. Franz was elected president of The Colorado Fuel and Iron Corporation at a meeting of the Board of Directors held in New York City.

Carl W. Meyers, who has been president of the company since 1946, was elected vice chairman of the board of directors.

Alwin F. Franz

Franz has been executive vice president of The Colorado Fuel and Iron Corporation since 1949, and a director since 1948. Prior to that, he served as vice president in charge of operations, and has managed the corporation's two largest plants. Until 1945 he was general superintendent of the Steel division of Alan Wood Steel Company.

Western Company Promotes L. O. Gore To Manage Panhandle-West Kansas

L. O. Gore has been promoted to sales manager of The Western Company's Panhandle-Western Kansas district. Wallace McBrayer has been transferred to that district as a sales representative.

Gore's office will be at district headquarters in Borger, Texas, while McBrayer will be assigned to the field station at Ulysses, Kansas.

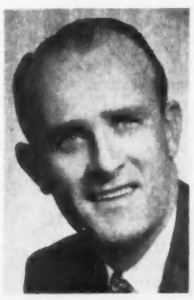
Gore is one of The Western Company's original employes, and when the company was organized in 1939, he operated one of its first field units. Before being made district sales manager, he was a Western sales representative in Liberal, Kansas. Gore also spent several years in the oil field supply business and with International Cementers, Inc.

McBrayer has been with The Western Company for about six months and was in the pumping services division of field operations at the company's field station in Odessa, Texas, before becoming a sales representative. He attended Texas Technological College in Lubbock and served in the Army Air Force during the war. Immediately before joining Western he was with Bob Daniels and Sons, Inc., in Hobbs, N. M.

EQUIPMENT and SERVICE SUPPLIERS' NOTES

C. T. Jones

Frank Smith



J. C. Norton

Red Kluck

B. G. Barefield

William Delaney

O-C-T Announces New Assignments For Sales and Service Personnel

Oil Center Tool Company announced several changes in and additions to its sales and service organization.

C. T. Jones and Frank Smith, salesmen in the West Texas area, have been named district manager and assistant manager respectively of the West Texas district.

J. C. Norton, formerly in the Alice, Texas, area for O-C-T, has been transferred to Dallas as district manager for the North Texas and Oklahoma area.

Red Kluck, formerly employed by Spiars Well Equipment Company and LeBus Rotary Tools, has joined O-C-T as salesman in the West Texas area.

B. G. (Bill) Barefield has been transferred from Houston to the Midland-Odessa area where he will be chief warehouseman in charge of assembly for the West Texas store.

William Delaney has been transferred to the Odessa branch as a serviceman.

Boyd Tops GM Diesel Sales

King D. Boyd, sales engineer of Stewart and Stevenson Services, Inc., Houston, has been named by Detroit Diesel Engine Division of General Motors as the 1951 leader in GM Diesel engine sales in the division's Central Southwestern sales zone.

THE MOST COMPLETE LINE

There are almost 1500 types and sizes in Laughlin's quality line of drop forged fittings.

There are many different styles of shackles, swivels, hooks, thimbles, clips, sockets, eye bolts and other products designed for a wide variety of applications throughout industry. If you use wire rope or chain, you can be sure that Laughlin has the right — *and safest* — fittings for the job.

THESE EXCLUSIVE PRODUCTS

Safety "FIST GRIP" Wire Rope Clips . . . Fool proof, easy to install Fist Grip clips hold rope more securely, can't go on wrong. Fewer clips are required than for ordinary types, and they will not crush or distort the rope.

SAFETY HOOKS . . . The latch locks the load, will not open until released by operator. Strong, drop forged steel hook has improved latch that leaves 80% of throat opening. 15 sizes; 3 patterns, eye, shank and swivel.

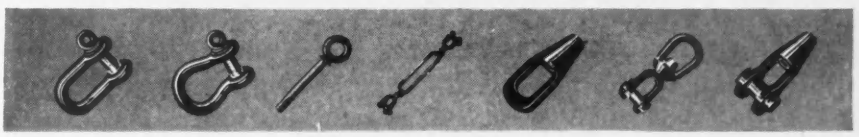
"MISSING LINK" (Reg. U.S. Pat. Off.) . . . Cheaper than welding, safer than cold shut or cast link, "Missing Links" go on in a jiffy and are stronger than proof coil chain. 17 sizes from 3/16" to 1⅞".

CLEVIS GRAB AND SLIP HOOKS . . . These sturdy hooks are easily attached to any welded link chain. Pin and cotter make it easy to attach or remove for use on another job. Needs no connecting fittings or special tools.

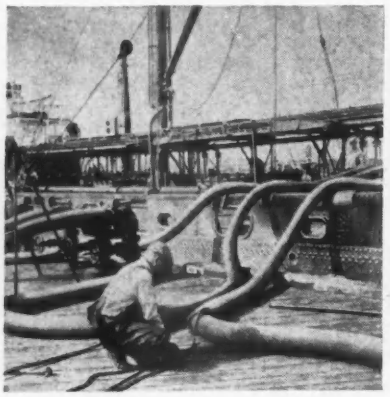
Laughlin's new Catalog No. 150 lists the complete line of drop forged wire rope and chain fittings with illustrations, description and specifications. Write for it today.

LAUGHLIN THE THOMAS LAUGHLIN CO.
413 Fore Street
Portland 6 Maine

THE MOST COMPLETE LINE OF DROP FORGED WIRE ROPE AND CHAIN FITTINGS



HEWITT-ROBINS



FOR FASTER TANKER TURN-AROUND

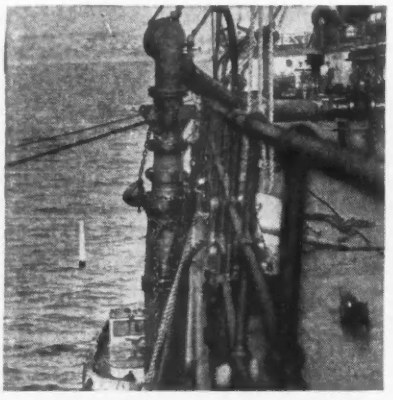
Hewitt-Robins Monarch® Oil Suction and Discharge Hose

Save up to 50% in loading and unloading time. Smooth bore, oil resistant innertube (originated by Hewitt-Robins) cuts friction resistance to a minimum . . . drains clean, as there are no wire "fuel traps" inside.

Prevents nipple leakage—Special Hewitt-Robins Durabond® process assures perfect adhesion of tube to metal . . . tube can't pull loose—it's bonded to tough duck carcass.

Right for heavy service—Strong and flexible, light in weight and easier to handle than rough bore hose.

Call your Hewitt Rubber Distributor (see "Rubber Products", classified phone book) or write for descriptive literature.



STEP UP OFF-SHORE SERVICE

Hewitt-Robins Sea Loading—Barge Loading Hose

For Sea Loading: Monarch® Sea Loading Hose has smooth bore. No coil of wire projects inside the tube . . . turbulence is cut to a minimum . . . flow increased up to 50%.

For Barge Loading: Conservo® Barge Loading Hose recommended for light barge petroleum service . . . comparatively low pressures, no severe handling. Smooth bore for fast flow. Available with either built-in steel nipples or integral rubber flange with swiveling bronze backup ring.

Get complete facts about all types of Hewitt-Robins hose. Call your Hewitt Rubber Distributor (see "Rubber Products", classified phone book) or write for descriptive literature.

HEWITT-ROBINS INCORPORATED

STAMFORD, CONNECTICUT

EQUIPMENT and SERVICE SUPPLIERS' NOTES

Baroid Sales Advances P. A. Newton To Supervise East Texas District

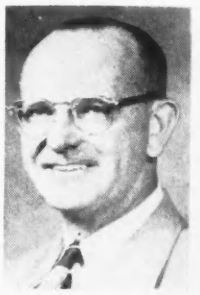
Baroid Sales Division, National Lead Company, has named Paul A. Newton East Texas district superintendent, with offices in Tyler, Texas.

P. A. Newton

Newton majored in science and mathematics at Upper Iowa University, and before joining Baroid in 1946 had been a science instructor and a Navy navigation officer. His experience with Baroid includes work in South Texas and South Louisiana fields. Since March, 1951, he had been stationed at Corpus Christi.

Cummins Sales & Service Advances Calnon to Vice President—Sales

J. T. Calnon has been promoted from sales manager to vice president—sales for Cummins Sales & Service, Inc., Fort Worth.



J. T. Calnon

Calnon's sales and service experience includes work as district service manager at Houston and Wichita Falls, division service manager in Odessa, and sales manager in Fort Worth. He will be in charge of Cummins engine sales throughout the company's area of operations.

During World War II Calnon served in the South Pacific on the USS Whitney as chief petty officer in charge of diesel maintenance. Shore duty included time as an instructor at the Navy diesel school at Gulfport, Miss. Before coming to work for Cummins Sales & Service, Inc., Calnon was employed in the automobile industry.

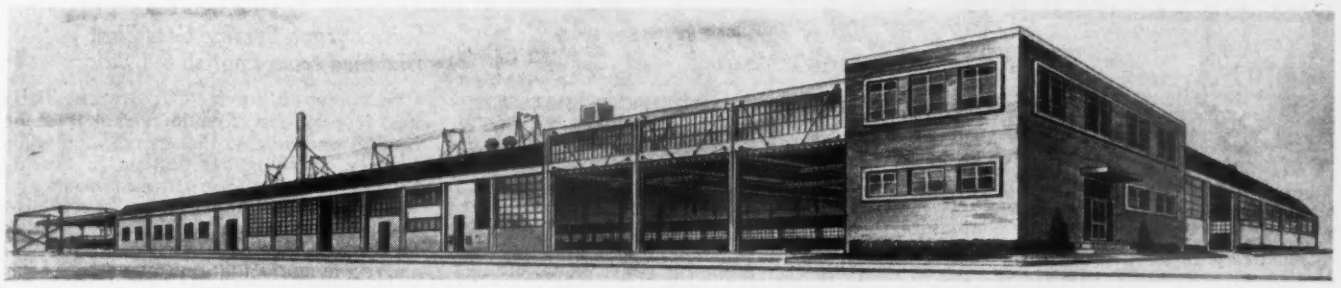
Jet Perforating Organization Names T. W. Painter Operations Manager

Welex Jet Services, Inc., Fort Worth, has appointed T. W. Painter, former supervisor of manufacturing, as operations manager. The firm's territory includes Arkansas, Kansas, Oklahoma, Texas, Louisiana and New Mexico.

T. W. Painter

Painter has a B.S. degree from the University of Idaho. He spent ten years with Robert W. Hunt Company, a consulting engineering firm in Chicago, and went to Fort Worth in 1947 as comptroller for Texasteel Manufacturing Company. He joined Welex in August, 1950.

PETROLEUM LIBRARY



HOBBS MANUFACTURING COMPANY's new Fort Worth trailer factory is pictured in this artist's sketch. The new plant, of concrete, steel and glass construction, covers an entire city block in the industrial area just north of the business district. By the new addition the company's plant square footage is increased 30 times from its original size which, 25 years ago, consisted of a 50 x 125-foot tin building. Officers of the company are M. J. Neeley, president and treasurer; W. E. Grace, vice president and general manager; and R. P. Akey, vice president in charge of production.

Hagn Is Elevated to Top Executive Positions in Chiksan Organization

B. J. Hagn has been elected president and a director of Chiksan Company, with headquarters at Brea, Calif. W. Edgar Spear, former president, has been advanced

B. J. Hagn

J. H. Robinson

to chairman of the board of directors, and J. H. Robinson has been elected a vice president and appointed general manager of Well Equipment Manufacturing Corporation, a division of Chiksan Company, with headquarters in Houston.

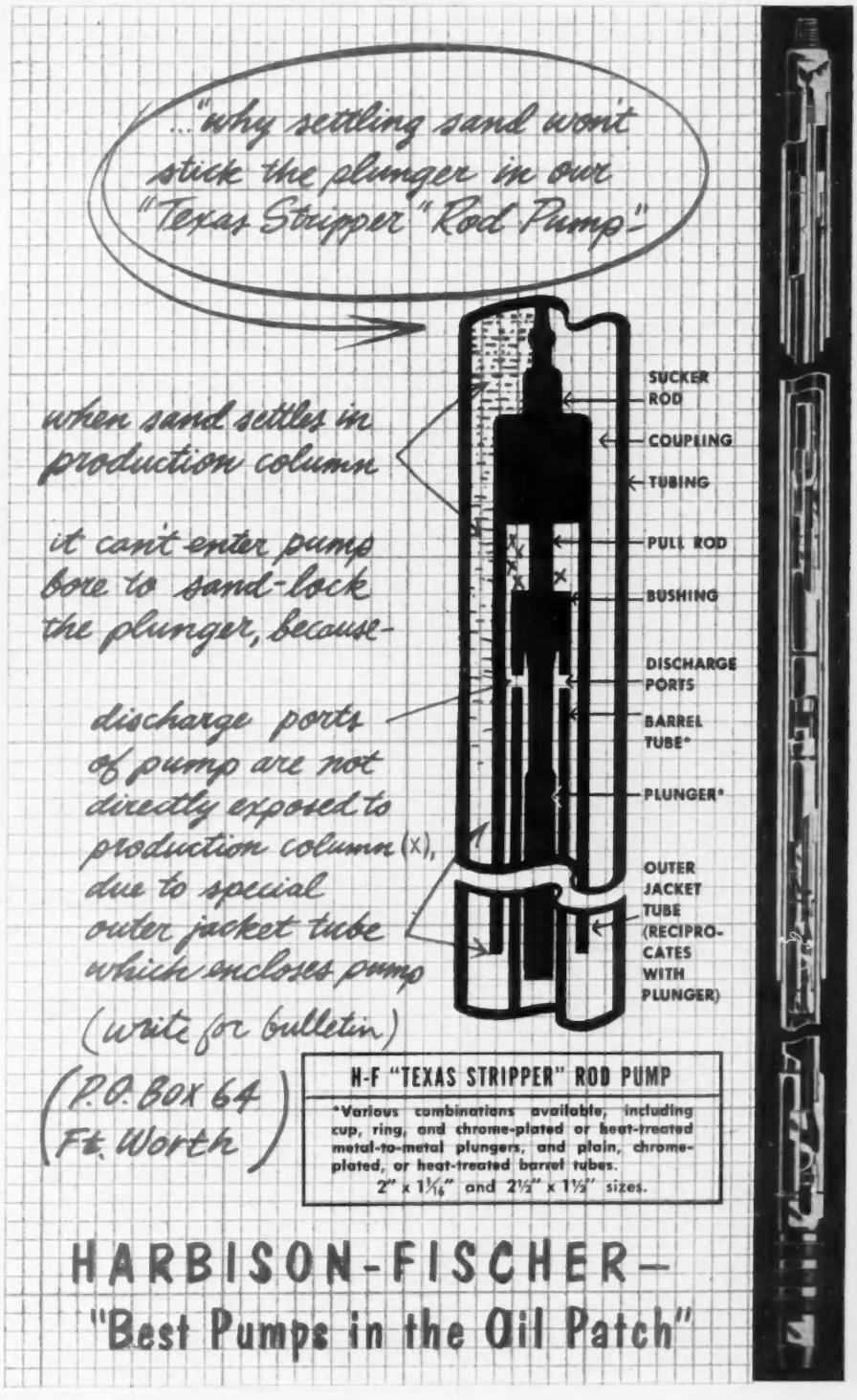
Hagn became head of the accounting department in 1937, and subsequently, secretary and treasurer. In 1946, he was named vice president and general manager of Well Equipment Manufacturing corporation.

Robinson joined Weco as a salesman in 1940, and assumed administrative duties in 1942. In 1946 he became secretary and treasurer.

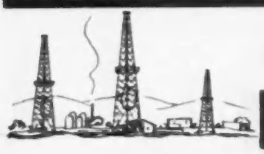
BS&B Opens San Francisco Office To Handle Oil Field Product Line

Black, Sivalls & Bryson, Inc., Kansas City, has opened a new California sales office at San Francisco, 55 New Montgomery Street. The new office will handle complete line of BS&B oil field products.

Ross Baze, West Coast sales manager, Los Angeles, will be in charge of the office, locally assisted by Warren J. May, sales engineer.


..."why settling sand won't stick the plunger in our "Texas Stripper" Rod Pump"
when sand settles in production column
it can't enter pump bore to sand-lock the plunger, because-
discharge ports of pump are not directly exposed to production column (X), due to special outer jacket tube which encloses pump
(write for bulletin)
(P.O. Box 64 Ft. Worth)
SUCKER ROD
COUPLING
TUBING
PULL ROD
BUSHING
DISCHARGE PORTS
BARREL TUBE*
PLUNGER*
OUTER JACKET TUBE (RECIPRO-CATES WITH PLUNGER)
H-F "TEXAS STRIPPER" ROD PUMP
*Various combinations available, including cup, ring, and chrome-plated or heat-treated metal-to-metal plungers, and plain, chrome-plated, or heat-treated barrel tubes.
2" x 1 1/16" and 2 1/2" x 1 1/2" sizes.
HARBISON-FISCHER—
"Best Pumps in the Oil Patch"

WORLD OIL'S Trading Post



CLASSIFIED ADVERTISING

RATES: Regular Classified (undisplayed) set in this size type: 12 cents per word. Minimum charge, $3. Blind box address in our care counts six words. Replies forwarded without charge. **Situation wanted** ads, 6 cents per word. **Display ads,** set in suitably larger type with ruled border, $12 per column inch; situation wanted display ads, $6 per column inch. Ten percent discount for two or more insertions of same copy in consecutive issues. **All classified ads payable in advance. COPY DEADLINE:** 5th of month preceding date of issue. Send copy and checks to: **Trading Post Section, World Oil, P. O. Box 2608, Houston, Texas.**

FOR SALE

■ Well drills, spudders, rotaries, core-drills. **All sizes new and used equipment. Tools, drill pipe, cable, pipe. Fishing tools rented. Everything for well drilling. Pressey & Son, Pueblo, Colorado.**

■ NORTH DAKOTA AND SOUTH DAKOTA BASE MAPS. Base Maps of North Dakota and South Dakota: County outline, township and range, location of all wells, and operators names with total depths. Oil and Gas Fields. 1"—8 miles. Priced $5.00 each. COUNTY MAPS: fee ownership and lease with expiration dates. Scale 1"—4000 ft. Northwest Mapping Co. 117½ Fourth St. Bismarck, North Dakota.

■ TWO 150 horsepower F and T boilers located at Eunice, New Mexico. Makin Drilling Co., Box 131, Hobbs, New Mexico.

■ Two 150 HP 200# Kewanee Oil Field Boilers. New flues and staybolts. Will pass inspection. Located at Del Rio, Texas. D. D. Thomas, 809 San Angelo National Bank Bldg., San Angelo, Texas.

■ USED rotary and cable tool drilling tools. E. A. Kelly, Box 861, Oklahoma City. Phone 5-6407.

■ Two Used Model PTD-6 Superior Diesel Engines with Dual Fuel Equipment less Clutch. Engines now located at Waukesha Sales & Service, Inc., Odessa, Texas.
Price Each.....$4,500.00
F. O. B. Odessa, Texas. Waukesha Engine & Equipment Co. P. O. Box 5468, Terminal Annex, Denver 17, Colorado.

■ The following New Material at ½ Retail Price:
8 6" FE 90° Ser. 600 Cast Steel Base Elbows
4 8" FE 90° Ser. 400 Cast Steel Base Elbows
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If interested contact Mr. Bert Rogers, Texon, Texas..

■ Well Drilling Spudders and Rotaries, bought and sold. Immediate delivery in most cases. Specify your requirements. Contact Francisco Gonzales, Baker Export Co. Box 1128, Pecos, Texas.

■ One complete rotary well rig capable of going to 3000' Has 60' steel derrick, 6¾ x 14 mud pump, 2 Waukesha engines on butane, 2000' 4½" drill pipe. Drawworks and table hooked up direct through gear box. $15,000 cash or terms at 6%. Write Box 26, Dateland, Arizona.

■ Two oil leases in Ohio one 80 acre and one 96 acre tract. There are two old stripper wells on each tract, there are also plenty of locations to drill. Will furnish particulars. Box 39-W. WORLD OIL. P. O. Box 2608, Houston, Texas.

★ 1400 feet or less 3½" EUE or 2⅞" EUE drill pipe, new or good used. One 30 foot 4¾" drill collar, new or good used. Have PAD authorization for pipe. Box 41-W. WORLD OIL. P. O. Box 2608, Houston, Texas.

HELP WANTED

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PHYSICISTS
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In the fields of geophysics and well logging. Work includes the measuring, telemetering, recording and evaluation of electric, magnetic, acoustic, radioactive and other characteristics of earth materials. Laboratory located in Houston, Texas.

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Foreign Production Div.
P. O. Box 35, N. Y. 4, N. Y.

★ Salesman experienced in mud engineering to contact drilling mud distributors. Excellent opportunity. Wyotana Sales Co., 3401 Buffalo Drive, JUstin 3772—Houston, Texas.

EQUIPMENT and SERVICE SUPPLIERS' NOTES

Seismograph Service Gets First Dividend from English Subsidiary

Seismograph Service Corporation, Tulsa, has received its first dividend from its English subsidiary, Seismograph Service Limited, marking a milestone in the history of an unusual organization.

The English company was formed after World War II to make SSC's exploration service available on a basis compatible with the economic situation of much of the world, SSC President G. H. Westby said. Working capital of the organization was furnished by British concerns, while SSC arranged for equipment and technicians.

HELP WANTED

PETROLEUM ENGINEER OR GEOLOGIST—with broad general knowledge of the petroleum industry in East Texas, North Louisiana and South Arkansas, to fill position with well established firm in area. State qualifications in detail. Box 40-W. WORLD OIL. P. O. Box 2608, Houston, Texas.

WANTED TO BUY

■ Wanted to buy by Eastern manufacturer of oil country equipment: Small machine shop, 2,500 to 5,000 sq. ft. floor space. Machine tolerances required .010". Write Box Number 38w, c/o WORLD OIL, P. O. Box 2608, Houston, Texas.

BUSINESS OPPORTUNITIES

■ **WE WILL BUY Producing Oil Royalties.** Send Particulars. Standard Security Co., 111 Broadway, New York 6, New York.

Would like to get in touch with people or Co. wishing to buy producing oil properties. No brokers. P. O. Box 424, Arkansas City, Kansas.

DECALS

TRUCK LETTERING AND TRADEMARK decals made for your trucks. Easy to apply, uniform, distinctive, economical for small or large needs. Write for Catalog. Mathews Company, 827 S. Harvey, Oak Park, Ill.

PRINTED FORMS FROM STOCK

Immediate delivery of producing and pipe line forms made from our complete line . . . Write for completely illustrated catalog.

GULF PUBLISHING CO.
P. O. Box 2608 Houston 1, Texas

SITUATION WANTED

Drilling contractor operating in West Texas and New Mexico desires to contact small or medium-sized independent oil company who needs an operating manager. Personal interview desired. Twenty years experience in all phases of the oil industry. Address replies to Box 94-W, WORLD OIL, Houston 1, Texas.

PETROLEUM LIBRARY

New Books, Maps and Movies

IRA RINEHART'S 1952 YEARBOOK. Rinehart Oil News Company, P. O. Box 1208, Dallas. $25 to non-subscribers; $15 to subscribers to Rinehart's **Report.**

A compilation in two volumes of petroleum statistics for U. S. producing states, this annual publication is a round-up of information on 1951 exploration and development. An over-all survey of the industry's financial situation last year is presented as an introduction to the first volume. The numerous maps pinpoint fields and individual well locations, and field data for each state includes a summary of wildcatting and geophysical work, completions, discoveries, production history and geology. There is a special section devoted to the Spraberry Trend of West Texas.

TECHNICAL PUBLICATIONS — 1949. Standard Oil Development Company, 15 West 51st Street, New York 19. Selected circulation.

This 563-page book is volume four of a series of collections of tenchnical papers contributed to scientific societies by the staffs of the companies affiliated with Standard Oil Company (New Jersey). Six of the articles are concerned with petroleum geology and production, while the remainder are on manufacturing, physical chemistry and analysis.

PHOTOGEOLOGIC INTERPRETATION USING PHOTOGRAMMETRIC DIP CALCULATIONS. By D. H. Elliott. California Division of Mines, Ferry Building, San Francisco 11. 50 cents.

This 21-page report describes a method of calculating the angle of inclination of hill slopes and of strata on vertical aerial photographs, using no instrument other than a pocket stereoscope. The only additional equipment needed is a sheet of transparent acetate and a millimeter scale. The calculations generally have an accuracy to within $\pm$ 10 percent of the value observed in the field.

CLEANING CRUDE OIL AND UNFINISHED PRODUCTS TANKS. American Petroleum Institute, 50 West 50th Street, New York 20. $1.

Hazards which may be encountered in the cleaning of tanks and recommendations for planning and carrying out the job are discussed in this new API manual. Other subjects treated included selection and care of equipment, inspection procedures, removal of contents and isolation of the tank; tank ventilation, and testing for vapor or gas. Safety measures are emphasized.

NATIONAL STRIPPER WELL SURVEY AS OF JANUARY 1, 1951. Interstate Oil Compact Commission, Box 3127, State Capitol, Oklahoma City 5.

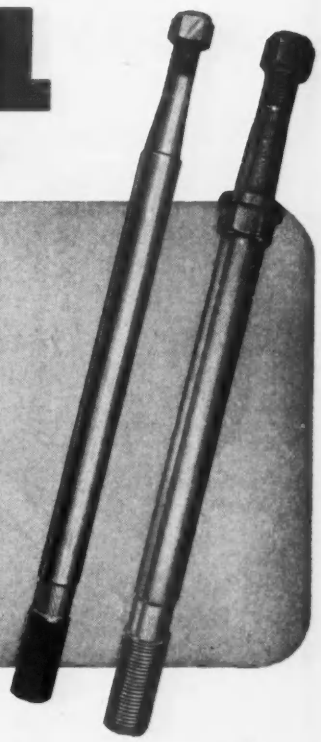
Reporting on a joint project of IOCC, National Stripper Well Association, and Independent Petroleum Association of America, this survey furnishes information relative to the magnitude and location of stripper well fields in the U. S. to date.

SECONDARY RECOVERY OPERATIONS IN WEST VIRGINIA, Interstate Oil Compact Commission, P. O. Box 3127, State Capitol, Oklahoma City 5. Free.

This report on a joint survey by the state of West Virginia and the IOCC, prepared by Alvah J. W. Headlee, chairman, and members of the West Virginia Secondary Recovery Committee, includes a paper by Douglas Rogers, Jr., on "Case Histories of West Virginia Gas Drives." Tables of the committee report include reservoir and fluid data, secondary recovery data, and a comparison of performances of West Virginia gas drives. Maps include a generalized geologic column for oil and gas fields and the location of secondary recovery projects up to 1951.

RED DEVIL

"DIA-HARD" PISTON RODS



For high pressure abrasive service

RED DEVIL Piston Rods are first choice where drilling conditions are severest because of the extreme hardness of the deep HIGH-CARBON wear resistant "DIA-HARD" case, coupled with tough core properties which give the highest tensile strength against breakage. All rods are hardness tested and precision gauged to maintain a world-wide reputation for quality. Write for Catalog No. P-101.

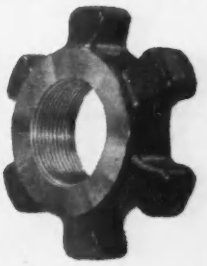
RED DEVIL PISTON PULLER

For tapered type rods

The usual practice of removing pistons from rods by blows of a sledge hammer often damages either pistons or rods. A Red Devil piston puller easily and quickly removes badly stuck pistons without injury to either part. All elements are made of finest quality alloy steel, heat-treated for strength and long life. Write for Catalog No. P-106.

RED DEVIL PISTON ROD LOCK NUT

These "Hammer Lug Type" nuts provide a fast and positive means for locking piston rod in crosshead. Made from alloy steel and heat treated, they will last indefinitely. Face of nut is precision machined for full seating surface at right angles to axis of threads to prevent fatigue stresses in rod. Write for Catalog P-102.



Complete information in Composite Catalog or write for price catalogs noted above. Red Devil products are available through your supply store.

OIL WELL MANUFACTURING CORP.

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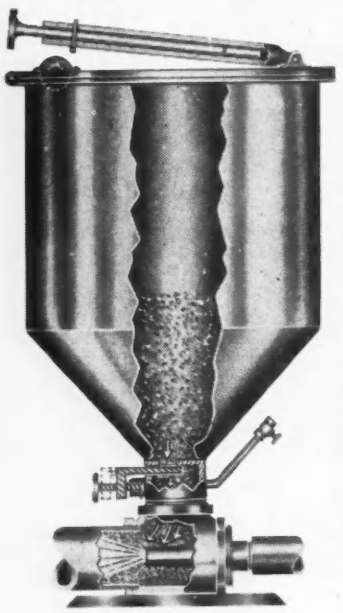
DRILLING EQUIPMENT MFG. CO.
DEMCO
OKLAHOMA CITY, OKLA. U.S.A.

SELF FEEDING
MUD
HOPPER



A compact lightweight unit, designed to provide the fastest method of mixing and controlling mud, at the lowest possible cost

- Provides simple and accurate control over viscosity and weight of mud.
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- Quick, easy bulk mixing made possible.
- Simple vacuum operation, no moving parts to wear, no complicated mechanism.
- Easy to operate, can be set to mix desired number of sacks per hour.

The exclusive design of the jet nipple and the mixing chamber provide more efficient mixing. Jet nipples are available in any size bore from 3/16" to 1".

NET WEIGHT 185 LBS.

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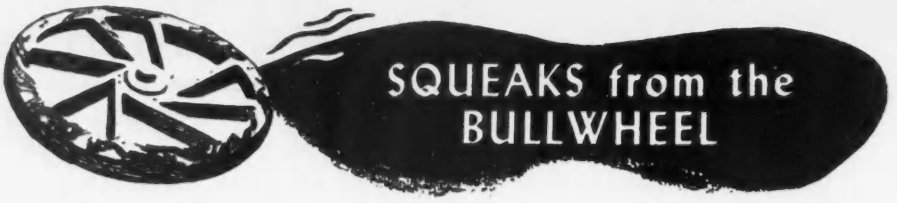


Capital Punishment

"What do you think of the two presidential candidates?"

"Thank goodness only one of them will be elected."

Parted Lovers

A davenport held the twain.
Fair damsel and her ardent swain;
Heandshe,
But then, a step upon the stair!
And father finds them sitting there:
He . . . and . . . she.

110 Proof

It has been said that a good test for quality of whiskey is to pass an electrical current through a fifth of the stuff. If the current causes a precipitation of lye, tin, arsenic, iron slag, and alum, the whiskey is only fair. If, however, the liquor chases the current back to the generator, you've got good whiskey.

Travel Fund

Professor: "Where is the capital of the United States?"

Student: "Well, most of it is in Europe."

Parable for Today

A man had been looking for a church to attend and he happened into a small one where the congregation was reading with the minister:

"We have left undone those things which we ought to have done, and we have done those things which we ought not to have done."

The man sighed with relief and dropped into a pew. "Thank the Lord," he said. "I've found my crowd at last."

Conspirator

Mother (putting Junior to bed): "Sh-h, the sandman is coming."

Junior: "Fifty cents and I won't tell daddy."

In the Know

Doctor: "Ask that accident victim his name, so we can notify his family."

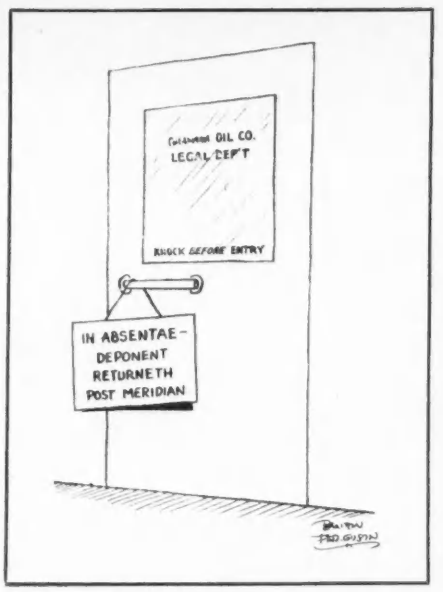
Nurse, a few minutes later: "He says his family already knows his name."

Wishy-Washy

The hired girl had been sent down to the brook to fetch a pail of water, but stood gazing at the flowing stream apparently lost in thought.

"What's she waiting for?" asked her mistress, who was watching.

"Dunno," wearily replied her husband. "Perhaps she hasn't seen a pailful she likes yet."



Full Value

When her beautiful bargain blouse split on the first wearing, Lizzie, the family cook, wasn't surprised. "I should of known," she said, "you don't git nothin' for nothin' but nothin.' "

Nature's Wonders

A couple driving across the Mojave desert saw in the distance a tiny black speck which, when they approached it, turned out to be a man wearing only his swimming trunks.

The man hailed them and asked: "How far is the ocean?"

Somewhat surprised, the couple explained that the ocean was a few hundred miles away, on the other side of California.

"Good Lord," said the man, staring at the sandy waste, "what a beach!"

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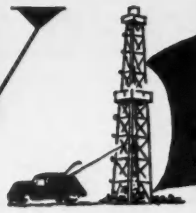

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NEW WAYS OF DOING THINGS

Latest News About New Tools, Techniques and Services

DID YOU KNOW THAT—

McCULLOUGH Bullet Type Gun Perforators are still the world's hardest shooting because these . . .

PERFORATORS have the STRONGEST body and have MORE powder under confinement for a given size gun—and they . . .

ARE made of SOLID steel with MORE alloy heat treated steel BEHIND the projectile, so they can withstand the GREATER explosive force of the confined powder. So these . . .

STRONGER McCullough Bullet Type Gun Perforators are always loaded to produce a pressure on the projectile just slightly under the yield point of the solid steel gun body . . .

RESULTING IN world records and making a habit of outperforming all others in actual production work, when others have failed—yet NEVER have other perforators followed McCullough and obtained additional production. So . . .

MORE B/D is your reward—not just once in awhile but consistently when you call for the McCullough Bullet Type Gun Perforator. Yet others persist in reporting results of surface tests which are inconclusive and misleading—mainly because conditions in every oil well are different and the various temperatures and pressures existing in wells are not duplicated when making tests . . .

SO REMEMBER that it takes a STRONGER perforator to shoot HARDER. And the McCullough Bullet Type Perforator is STILL the hardest shooting Bullet Perforator in the world!

SEE YOU AT THE RIG!

PERFORATING, TESTING AND FISHING SERVICE ANYWHERE—ANYTIME!

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Towering 180 feet into the air alongside Mid-Continent Supply Company field stores in West Texas and New Mexico, an orange and white tower is mute evidence of Mid-Continent's entry into the field of faster service and supply through the use of mobile radio-telephone.

The first of these installations in this oil rich area has been completed and is now in use serving the Snyder, Texas, area. Other installations are being completed as fast as equipment becomes available at Mid-Continent's other West Texas-New Mexico locations.

MID-CONTINENT
Supply Company
General Offices Mid-Continent Bldg. FORT WORTH, TEXAS

SQUEAKS FROM THE BULLWHEEL

Gift of Gab

An Irishman, inviting a friend to his wedding anniversary party, explained how to find him in the apartment building where he lived. "Come to the seventh floor," he said, "and where you see the letter 'D' on the door, push the button with your elbow and when the door opens put your foot against it."

"Why do I have to use my elbow and my foot?" asked his friend.

"Well for heaven's sake," exclaimed the Irishman, "you're not coming empty-handed, are you?"

•

Microcar

Driver of bantam auto: "Please give me a glass of water for the radiator and a thimbleful of oil for the motor and a half pint of gasoline."

Service station attendant: "Sure you don't want me to cough in your tires?"

•

Pardonable Pride

Shoulders thrown back proudly, the old mountaineer strode from the village post-office when the letter had been read to him.

Outside, he made his way immediately to a gathering of his cronies in the chinaberry's shade.

"My boy, Zeb," he announced so that all could hear, "has got his sentence cut down six months for behavin' good."

There was quick interest. A grizzled hillbilly raised himself on an elbow.

"Hit's moughty nice," he commented, "to have a boy that does you sech credit."

"Hey, Sam! Someone to see you—and, by the way, you owe me five bucks on that bet we made last March 15."

Bad Investment

First chorus girl: "I hear your millionaire's check bounced back."

Second C.G.: "Yeah, and it was marked 'insufficient fun'!"

•

Fritterer

The old man noticed the young fellow with a bottle in one hand and his arm around a pretty girl.

"The dern whippersnapper is wastin' a lot of time," he mused. "He can drink when he gets old."